THE ENGINEER.

High-Speed Lathes.

HIGH-SPEED LATHES.

THE special lathe for cutting metal at high speed is of quite recent origin. High-speed steel was first shown publicly in use at the Paris Exhibition of 1900, but since that date, that is to say in less than four years, not only have English steel makers outdistanced the whole world in the production of special tool steel, but the tool makers have met the call upon them for exceptionally powerful tools by a number of designs that seem to leave but little to be desired.

The problem that was set the lathe maker by the introduction of the new steel is by no means easy to solve. It was not, it is true, a difficult matter to increase the power of a lathe by enlarging the cone pulleys both in width and diameter. But by doing so only a partial solution was offered. Where we had been used to 3 or 5 horse-power, now 20 to 60 had to be consumed in lathes of even moderate dimensions. Hence the strength and proportion of parts demanded attention. Furthermore the desire to employ the fine material provided to the best advantage rendered it essential that every lathe should have a large range of speeds, and it was desirable that the change from one to another might be quickly effected. The fast headstock therefore required careful revision as a whole, and we shall show how many and varied are the designs which an attempt to combine flexibility of speed with great power and efficiency under all possible conditions has brought about. We may particularly direct attention to the development of the all-gear head, which present indications point to as the design of the future, particularly where electric driving is employed.

But it was not only the fast headstock that required revision—the loose headstock also soon began to show need of attention, and it is still the weak place in many designs. The tremendous forces that have to be withstood by the back centre have not, perhaps, in the absence of definite figures, been fully grasped. Now, however, that we know with a good deal of certainty that pressures of as much as 8 to 10 tons have to be borne by the cutting tool we may roughly estimate the pressure that the loose headstock has to resist. Obviously, the worst possible condition must be considered, that is when the tool is closest to the back centre. In this case the pressure tending to lift the work upwards where a single tool is used is but little short of the whole pressure on the tool, and the force trying to thrust it back due to the inclination of the back centre will be getting on for 5 or 6 tons. These figures are but rough estimates. There is probably beside the vertical force a thrust away from the tool which is not easily measured. Dr. Nicholson's tests point to it being in the neighbourhood of about one-third of the vertical pressure. The case is further complicated by the fact that the tool is generally pressing the work away from the back centre on a more or less axial line. Hence in the absence of any experimental data it is not possible to say with any certainty to what the stresses to be borne by the back centre amount, but there can be little doubt that as from five to ten times the amount of work is done in these lathes as in old lathes, a more powerful loose headstock is an absolute necessity.

To design one is in itself no easy problem, and the drawings that we are able, through the courtesy of several makers, to put before our readers merit careful study. The spindle and its appurtenances do not present many difficulties, and practically the whole trouble may be resolved into the matter of holding the main casting rigidly on the bed. The one bolt that was sufficient in old lathes is now useless, and three, four, or more have to be used. If the base of the headstock could be made to span the bed and be clamped on the edges of the shears, rigidity might be fairly easily attained; but this design is in general precluded by the necessity of taking extensions of the slide rest past the back centre. In some lathes, however, it is possible to employ it, and we show several designs —see Figs. 12 and 13—by Messrs. Hulse and Co. where this plan is used. Where, however, as in the majority of instances, it is not possible to work in a design of the kind, bolts and a keep plate have to be employed, and to so design matters as to get bolts in is not easy, for the bolts should certainly be short, and the practice of taking them through to the barrel is not to be commended. It must be remembered that steel is elastic, and under the stresses to which it is subjected it lengthens. The longer the bolt the more it stretches. It is for this reason almost impossible to make long bolts hold rigidly. There is always a certain very small amount of extension and contraction going on in them with every change of load. Hence we repeat short bolts only should be used, and the shorter the better. Several examples of good loose headstocks will be found further on, and we may, perhaps, point especially to the Tangye design, which is illustrated by drawings in Figs. 47 and 49, and which seems to meet very well the condition laid down. The 12in. design has, it will be seen, a spindle of the abnormal diameter of 4½in. Other makers are content with about 3½in. for this size lathe. Attention may also be directed to the new design that Hetheringtons propose employing in all their high-duty lathes for the future. It is illustrated by Fig. 7, page iv. Tee slots, it will be seen, are worked all along the bed and provide accommodation for as many bolts as may be deemed necessary, and these shorter than are possible with keep plate designs. Dean, Smith, and Grace employ a similar design in a large lathe, 28in. centres, illustrated in Fig. 36, page xii. Lang's design with solid spindle is also excellent. It will be observed that in the two special designs by Hulse, illustrated in Figs. 12 and 13, the beds are duplex. Both the lathes are of very large size, so that in a sense the cases presented are exceptional. Where single beds have to be dealt with objection is felt to clamping on to the guiding edge for the carriage, and thus even where it would be possible to do so it is rare for the base of the loose headstock to extend over the edges of the shears.

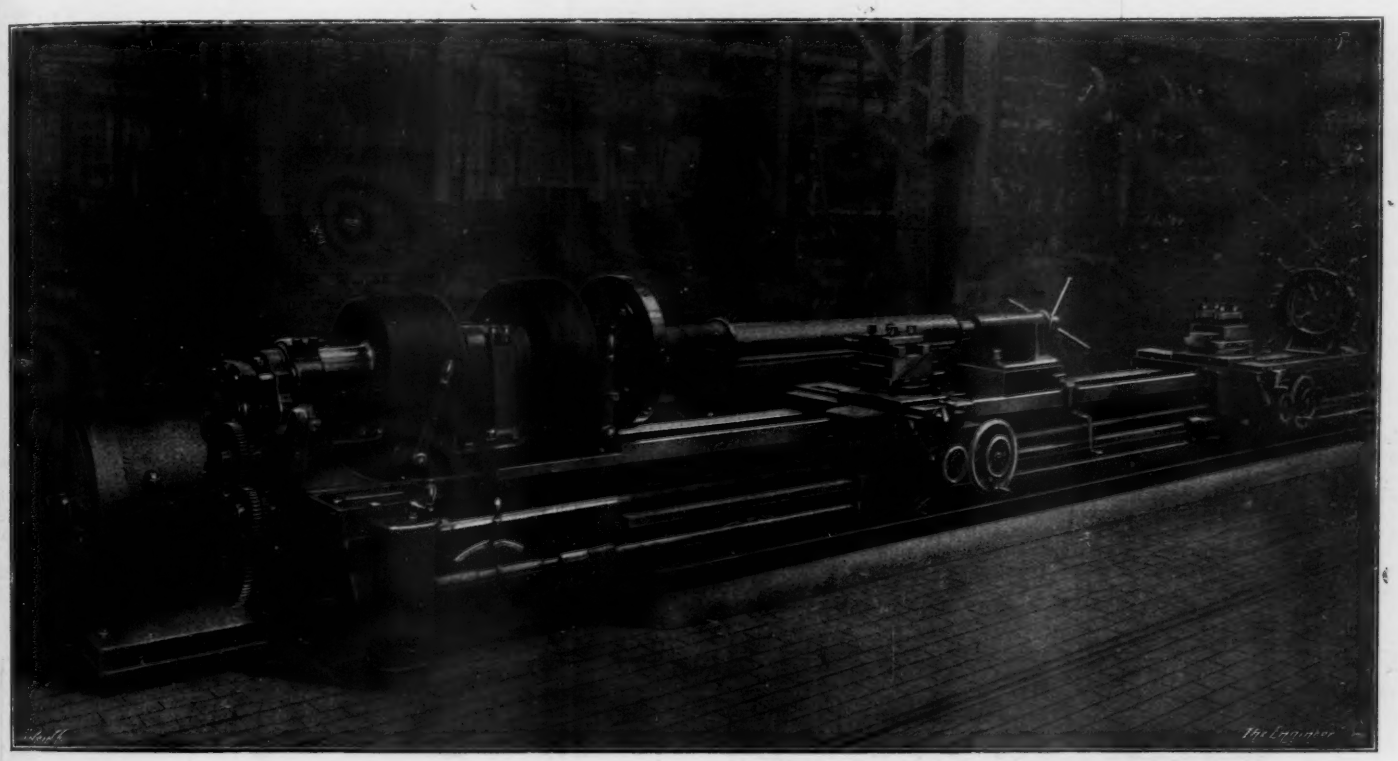


FIG. 1—18-INCH ELECTRIC SHAFTING LATHE—DARLING AND SELLERS

There is another point of some interest in connection with the loose headstock, and that is the back centre proper. Several makers are giving it their attention in the hope of finding some method of reducing the troubles produced by friction under the great loads that have to be faced now-a-days. So far we have not heard of anything that can satisfactorily replace the ordinary loose centre, but it may be worth while to mention a remarkable device tried by Tangyes and which was very satisfactory for light work. In place of the ordinary centre a hard steel cup, with a 60 deg. angular hole in it, was used. A hard steel ball rested in this hole, and in the similar hole in the work, which was thus supported. The ball worked round under light loads, and was satisfactory; but when heavier work was tried it stuck fast, and soon heated. The fact that the experiment was not successful makes it none the less interesting.

Loose centres, too, are beginning to give trouble by sticking, and it has been found that the old method of forcing them out by making the screw long enough to thrust against them, when the spindle was screwed home, is unsatisfactory, and in one case of a fairly large lathe which came to our notice, the screw was buckled up in the endeavour to force out the centre. For this reason the practice, which is common in large lathes of putting a forcing nut round the loose centre to start it, may be found necessary in lathes of medium size designed for high power.

By the excellent paper on the design of headstocks that he read at the Manchester Association of Engineers in November, 1903, Mr. P. V. Vernon, of Messrs. Alfred Herbert's, has constituted himself one of our leading authorities on this subject, and the following discussion

of high-speed headstocks has been kindly contributed to this Supplement by him. It bears largely, it is true, on the design of headstocks of a special kind, but it is in a large measure generally applicable, and it will, we think, be read with interest.

In this article Mr. Vernon outlines a method by which the varying factors of belt speed, gear ratio, work speed and work diameter may be amalgamated into a series of numerical quantities, which will indicate the value of the driving gear and the amount of cut which can be taken on all diameters of work at all cutting speeds.

The introduction of high-speed steels has in many respects altered the conditions governing the design of lathe headstocks. In the case of the ordinary headstock, as hitherto made, whether double or treble geared, the conditions were, broadly speaking, that the maximum amount of torque on the spindle was required at the slowest speed, the minimum amount being required at the highest speed, the torque varying inversely as the speed between these limits. These conditions have never been quite fulfilled owing to the variations of belt power due to the different diameters of the various steps of the cone pulleys and to the changes in countershaft speeds, the ideal requirement under the old conditions being, of course, a constant speed belt, the whole of the speed changes being made in the headstock between the belt and the spindle.

The older designs of headstocks were found to be fairly satisfactory for use with ordinary tool steel, but the introduction of high-speed steels has changed the conditions. The torque has with it no longer any particular relation to the speed at which the spindle rotates—that is to say, that the same lathe may require to take a heavier cut on a given diameter at a high speed using high-speed steel than on the same diameter at a lower speed using ordinary steel.

If lathes could be set apart for use with high-speed steel only, then the conditions would be similar to those hitherto in force with ordinary steels, the average spindle speed, however, being raised in proportion to the greater cutting speed possible with high-speed steel. Specialisation, however, has only reached this point in a limited number of cases, and in producing a machine for a variety of work it is found necessary not only to have the correct power and speeds for high-speed steels, but also for ordinary tool steels. The example selected to illustrate this article is the design of a headstock for dealing with work made from the solid bar, and which is driven by a cone pulley and gearing. The general principles laid down, however, will be applicable to headstocks for general work, and, in fact, also to the driving mechanism of other machine tools than lathes.

The direct-connected motor-driven machine is, of course, specially suitable for use with high-speed steels if properly designed, but at the present stage of workshop practice direct motor-driven tools are only used in a limited number of cases, and although they will probably increase largely in the future, yet at the present time the cone-driven machine is doubtless of a more general interest to the average user.

The conditions to be met in the case of a headstock for bar work are as follows:—It must have sufficient range of speeds for both high-speed steel and ordinary steel tools. It must have speeds slow enough for screwing the maximum diameter with dies made of ordinary steel. It must have sufficient power at the high speeds to take heavy roughing cuts.

The ordinary double-geared headstock fails on the high speeds owing to the fact that the gearing is out of action, and the belt-drive alone is not powerful enough for heavy cutting. To remedy this either the cone-pulley must be increased in diameter or width, or both, or gearing must be introduced on the high speeds.

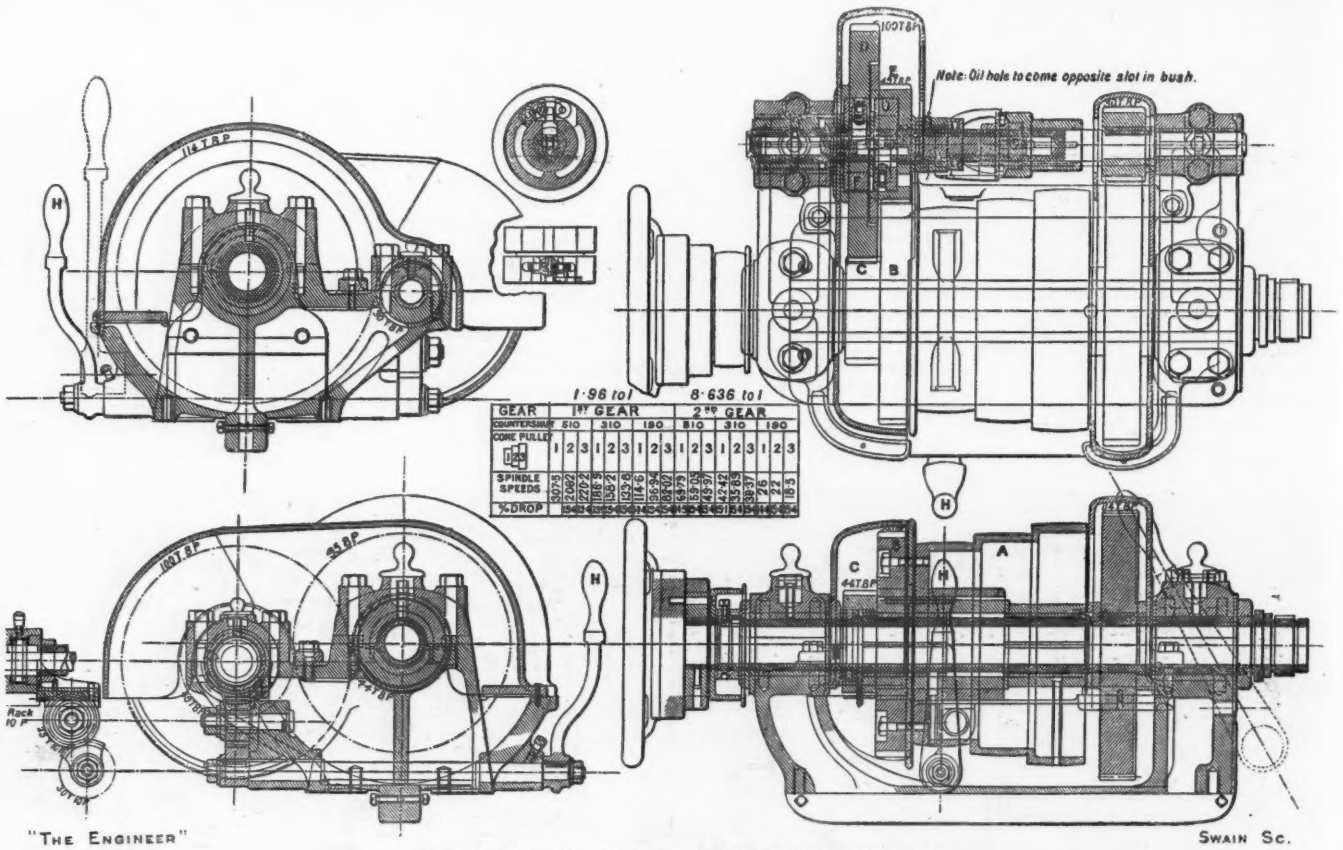
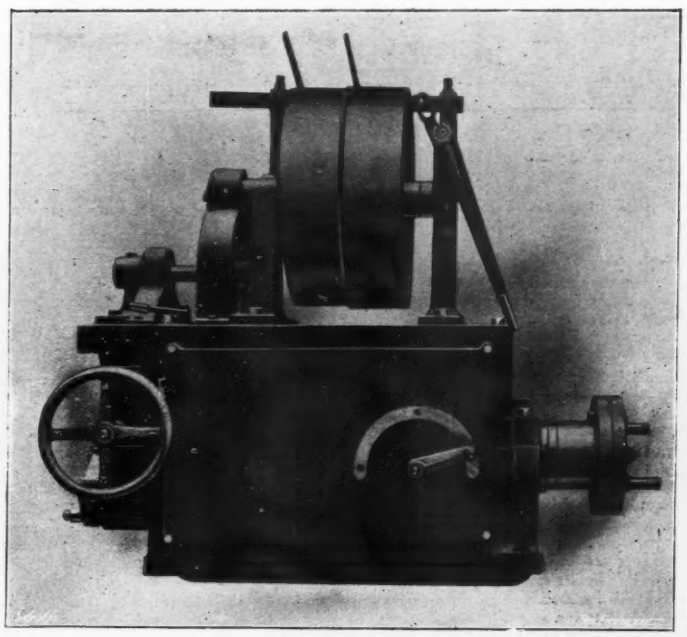
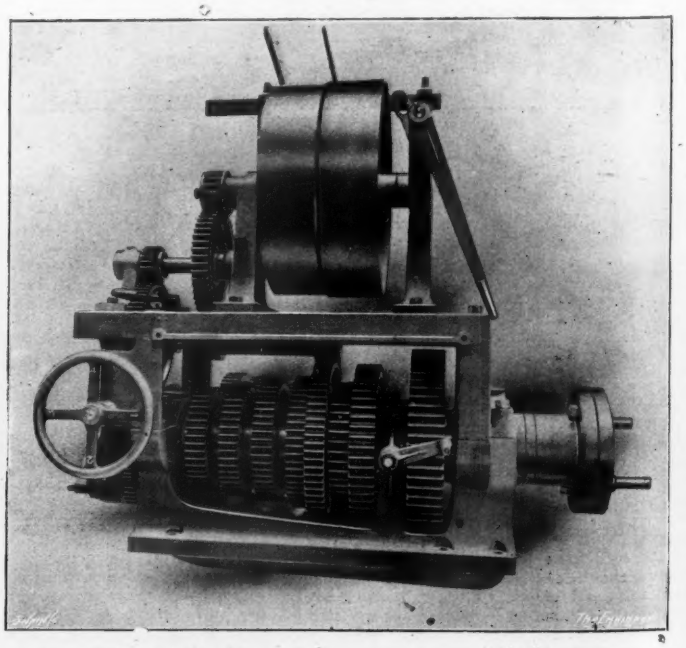


Fig. 2—HIGH-SPEED HEADSTOCK—ALFRED HERBERT, LIMITED





Figs. 3 and 4—HIGH-SPEED HEADSTOCK—J. HETHERINGTON AND SONS

for connecting the cone pulley direct with the spindle will not be required, as the cone pulley will always run at speeds which are higher than the spindle ever requires to run.

A headstock designed on these lines is shown by Fig. 2 on page ii., which has been constructed by Messrs. Alfred Herbert, Limited, Coventry, for dealing with bar work on hexagon turret lathes. It will be seen that in general appearance the headstock resembles an ordinary double-geared headstock, but, nevertheless, shaft drives the spindle through a pinion and gear at an invariable speed ratio. The speed table, Fig. 2, shows how each spindle speed is obtained, and it should be noticed that the geometrical progression is adhered to as closely as the pitches of the gears will allow.

Another point worth noting is the large diameter of the smallest step of the cone pulley, which is larger than the largest step of the cone pulley of many headstocks of this height of centres, and by referring to the speed table it will be seen that the arrangement of the speeds is such

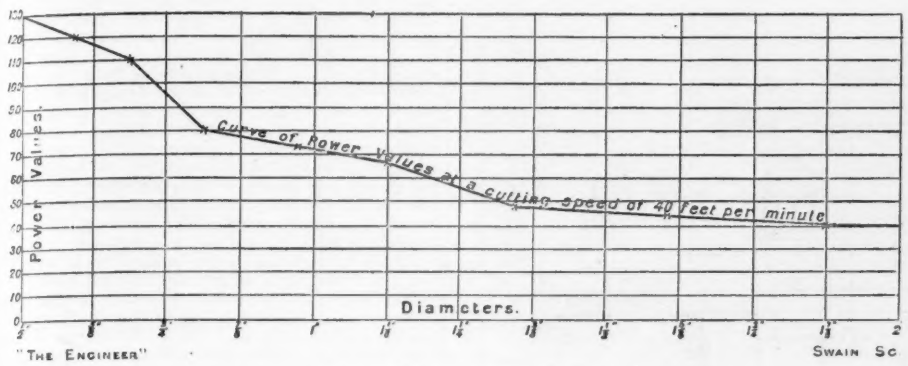


Fig. 5—CURVE OF POWER VALUES

8in. Centre High-speed Headstock. Table of Power Values.

Square inch of belt per turn of spindle / Spindle speeds ..	GEAR 1·96 to 1.																	
	203·2 / 307·5		221·6 / 260·2		240·1 / 220·2		233·2 / 183·9		221·6 / 158·2		240·1 / 133·8		203·2 / 114·6		221·6 / 93·9		240·1 / 82	
Diameters.	Feet per min.	Power value.	Feet per min.	Power value.	Feet per min.	Power value.	Feet per min	Power value.	Feet per min.	Power value.	Feet per min.	Power value	Feet per min.	Power value.	Feet per min.	Power value.	Feet per min.	Power value.
¼in.	20·1	258·6	17	282·2	14·4	305·7	12·2	253·6	10·3	282·2	8·7	305·7	7·5	258·6	6·3	282·2	5·4	305·7
⅜in.	30·2	172·5	25·5	188·1	21·6	203·9	18·4	172·5	15·5	188·1	13·1	203·9	11·2	172·5	9·5	188·1	8·1	203·9
½in.	40·2	129·3	34	141·1	28·8	152·9	24·5	129·3	20·7	141·1	17·5	152·9	15	129·3	12·7	141·2	10·7	152·9
⅝in.	50·3	103·5	42·5	112·8	36·1	122·3	30·5	103·5	25·8	112·8	21·9	122·3	18·7	103·5	15·9	112·8	13·4	122·3
¾in.	60·4	86·2	51·1	94	43·1	102	36·7	86·2	31·1	94	26·3	102	22·5	86·2	19	94	16·1	102
⅞in.	70·4	73·9	59·5	80·6	50·4	87·4	42·8	73·9	36·2	80·6	30·6	87·4	26·2	73·9	22·2	80·6	18·8	87·4
1in.	80·5	64·7	68·1	70·5	57·6	76·5	48·9	64·7	41·4	70·5	35	76·5	30	64·7	25·4	70·5	21·4	76·5
1⅛in.	90·6	57·5	76·6	62·7	64·8	67·9	55	57·5	46·6	62·7	39·5	67·9	33·7	57·5	28·5	62·7	24·2	67·9
1¼in.	100·6	51·7	85·1	56·4	72·1	61·1	61·2	51·7	51·7	56·4	43·8	61·1	37·5	51·7	31·7	56·4	26·8	61·1
1⅜in.	110·7	47	93·6	51·3	79·2	55·6	67·3	47	56·9	51·3	48·1	55·6	41·2	47	34·9	51·3	29·5	55·6
1½in.	120·7	43·1	102·2	47	86·5	50·9	73·4	43·1	62·1	47	52·5	51	45	43·1	38·1	47	32·2	51
1⅝in.	130·8	40	110·7	43·4	93·7	47	79·5	40	67·3	43·4	56·9	47	48·7	40	41·2	43·4	34·9	47
1¾in.	140·9	37	119·2	40·3	100·9	43·7	85·6	37	72·5	40·3	61·3	43·7	52·5	37	44·4	40·3	37·6	43·7
1⅞in.	150·9	34·5	127·7	37·6	108·1	40·7	91·7	34·5	77·6	37·6	65·7	40·7	56·2	34·5	47·6	37·6	40·3	40·8
2in.	161	32·3	136·2	35·3	115·3	38·2	97·9	32·3	82·8	35·3	70	38·2	60	32·3	50·7	35·3	42·9	38·2

Square inches of belt per turn of spindle .. .. / Spindle speeds ..	GEAR 8·636 to 1.																	
	895·1 / 69·8		976·5 / 59·1		1058·1 / 49·9		895·1 / 42·4		976·5 / 35·9		1058·1 / 30·4		895·1 / 26		976·5 / 22		1058·1 / 18·5	
Diameters.	Feet per min.	Power value.	Feet per min.	Power value.	Feet per min.	Power value.	Feet per min.	Power value.	Feet per min.	Power value.	Feet per min.	Power value.	Feet per min.	Power value.	Feet per min.	Power value.	Feet per min.	Power value.
¼in.	4·6	1139·7	3·9	1243·3	3·3	1347·2	2·8	1139·7	2·3	1243·3	1·9	1347·2	1·7	1139·7	1·4	1243·3	1·2	1347·2
⅜in.	6·9	759·8	5·8	828·9	4·9	898·2	4·2	759·8	3·5	828·9	2·9	898·2	2·5	759·8	2·2	828·9	1·8	898·2
½in.	9·1	570·1	7·7	621·8	6·5	673·9	5·5	570·1	4·7	621·8	3·9	673·9	3·4	570·1	2·8	621·8	2·4	673·9
⅝in.	11·4	455·9	9·6	497·4	8·2	539	6·9	455·9	5·8	497·4	4·9	539	4·3	455·9	3·6	497·4	3	539
¾in.	13·7	379·9	11·6	414·4	9·8	449·1	8·3	379·9	7	414·4	5·9	449·1	5·1	379·9	4·3	414·4	3·6	449·1
⅞in.	16	325·7	13·5	355·3	11·4	385	9·7	325·7	8·2	355·3	6·9	385	5·9	325·7	5	355·3	4·2	385
1in.	18·3	285	15·5	310·9	13·1	336·8	11·1	285	9·4	310·9	7·9	336·8	6·8	285	5·7	310·9	4·8	336·8
1⅛in.	20·6	253·3	17·4	276·3	14·7	299·4	12·5	253·3	10·6	276·3	8·9	299·4	7·6	253·3	6·5	276·3	5·4	·4
1¼in.	22·8	227·9	19·3	248·6	16·4	269·4	13·9	227·9	11·7	248·6	9·9	269·4	8·5	227·9	7·2	248·6	6·1	
1⅜in.	25·1	207·2	21·2	226	17·9	245	15·3	207·2	12·9	226	10·9	245	9·4	207·2	7·9	226	6·6	245
1½in.	27·4	189·6	23·2	207·2	19·6	224·5	16·6	189·6	14·1	207·2	11·9	224·5	10·2	189·6	8·6	207·2	7·3	24·
1⅝in.	29·7	175·3	25·1	191·3	21·2	207·2	18	175·3	15·3	191·3	12·9	207·2	11·1	175·3	9·4	191·3	7·9	207·2
1¾in.	31·9	162·8	27·1	177·6	22·9	192·5	19·4	162·8	16·4	177·6	13·9	192·5	11·9	162·8	10·1	177·6	8·5	192·5
1⅞in.	34·2	152	28·9	165·7	24·5	179·6	20·8	152	17·6	165·7	14·9	179·6	12·7	152	10·8	165·7	9·1	179·6
2in.	36·5	142·5	30·9	155·4	26·2	168·4	22·2	142·5	18·8	155·4	15·9	168·4	13·6	142·5	11·5	155·4	9·7	168·4

embodies the essential differences outlined above, and gives approximately double the power of a headstock of similar size designed in the ordinary way, at all speeds.

The cone pulley *a* runs loose on the spindle at all times, and carries two gear wheels *b* and *c*, which transmit motion to two other gears *d* and *e* running loose on the back shaft. Either of these two gears can be coupled to the back shaft by friction clutches *f* and *g* of the expanding type, the construction of which can be seen in Fig. 2, and which have been previously described in THE ENGINEER in connection with other lathes made by the same firm. The two clutches are operated by means of a lever *h* on the front of the headstock through a quadrant, rack, and intermediate gear shown separately in elevation in Fig. 2; the back shaft thus has two speeds for each speed of the three-step cone pulley, and as the countershaft has three speeds, eighteen speeds in all are obtained. The back as to secure this result, the three steps of the cone pulley always giving three consecutive speeds, thus keeping the total range of speeds given by the cone as low as possible, and enabling the small step to be made as large as possible relatively to the large step. This is a point of importance if it be desired to avoid weak places in the speed range.

Comparing the speeds of the headstock with the conditions laid down, it will be seen that the speed range of 18·5 turns up to 307·5 turns per minute in geometrical progression will cover practically all the requirements when turning bars up to 2in. diameter, either with ordinary or with high-speed steel cutters, and also gives speeds slow enough to screw 2in. Whitworth threads, using dies made of ordinary steel; and at the same time it should be noted that the gearing assures practically twice the amount of belt passing over the cone pulley per turn of the spindle on all speeds as compared with the ordinary double-geared headstock.

A hollow spindle lathe for high-speed bar work labours under the disadvantage of high rubbing speed in the bearings, as the spindle is necessarily larger in diameter than the strength requires, in order to obtain the required internal capacity. On this account it has been found advantageous on this lathe to provide extra long bearings, and to adopt the syphon system of lubrication, so as to give a continuous oil feed to the bearings. The way in which this is accomplished is perfectly clear from the drawings. As an example of what has been done, the following will be of interest:—A 1⅞in. mild steel bar was reduced to ¾in. diameter at one cut, the cutting speed was 104 turns per minute = 51ft. per minute. The feed was 22 cuts per inch = 4·72in. travel per minute approximately. The tool was 1in. deep, ¾in. wide, and was made of high-speed steel, the weight removed by the single tool being 2·84 lb. per minute.

Although this figure may not be high compared to some others which have been published, yet it is very heavy duty for a single tool on such a small diameter of bar as 1⅞in. With an ordinary headstock and the usual fine feed, one-third of the above would be considered satisfactory, even with high-speed steels, and with ordinary tool steel about one-sixth would not seem by any means slow. It will be understood that no ordinary 8in. headstock, speeded in the ordinary way would have sufficient power to take the above cut at 104 turns per minute.

On the question of the horse-power required for driving machine tools, a very good approximate rule is to allow 1 horse-power for every 10,000 square inches of belt passing over the pulley per minute. This rule is based upon an effective driving belt tension of 39·6 lb. per inch of belt width, which is about in agreement with ordinary practice for fair working belt tensions. It must be remembered, however, that the horse-power gives no measurement of the size of cut which can be taken until the cutting speed is taken into account, owing to variations of cone diameters and gear ratios in the headstock, and what is required is a measurement which will take into account both power and speed on all diameters of work.

Several suggestions have been made recently as to establishing a standard for estimating the power of headstocks, and most of the suggestions have been based upon the maximum pulley diameter and the maximum gear ratio. Consideration of the points discussed above as to the relations between speed and power, however, makes it clear that such a standard would be misleading, as in the majority of cases, especially with high-speed steel, the maximum gear ratio is not in use, and in very many cases the belt is not upon the largest step of the cone, when the required work is to be done.

In stating the strength of a chain, consideration must be paid to the strength of the weakest link, and the same course should be adopted when estimating the value of a machine tool for any given work, and the idea, therefore, almost suggests itself that it would be as reasonable to estimate the power of a lathe by the minimum values of cone pulley diameter and gear ratio as by their maximum values. In estimating the power of a lathe for any work it is necessary to take into consideration that part of the speed range at which the work must be done in order to get the required cutting speed suitable for the tool steel used, and on this account it seems that a better basis can be arrived at from the quantity of belt passing over the pulley (width multiplied by velocity) per inch or foot of cut at certain specified cutting speeds on the various diameters. Such a method takes into account the various efficiencies on the different steps of the cone pulley, and also does not encourage the formation of a mistaken estimate based on a high ratio of gearing which could never be used with the high-speed steel tools.

A method of accomplishing this is by constructing a table, as shown above, giving the consecutive spindle speeds in a horizontal line, and the diameters to be dealt with in a vertical column.

The projected squares contain the cutting speeds in feet per minute for the various diameters at the different spindle speeds, and also contain a function which may be called the "power value," and which consists of

$$\frac{\text{Square inches of belt passing over cone pulley per minute}}{\text{Linear inches of cut per minute.}}$$

The sectional area of cut which can be taken at any required cutting speed on a given diameter will vary with the power value, which therefore forms a rational basis for comparison, no matter what design of headstock may be in question. To obtain the power value for a motor-driven machine the following formula may be used:—

$$\frac{\text{Horse-power of motor} \times 10{,}000}{\text{Linear inches of cut per minute}} = \text{power value,}$$

which is based on the rule for horse-power given above. The horse-power in the case of a variable speed motor is, of course, to be taken as the actual horse-power which the motor will develop at the speed required for the work, and will vary for different parts of the speed range. The stepped line in the table separates those cutting speeds which are above from those which are below 20ft. per minute, and other similar lines can be added as required for connecting any required series of cutting speeds. The actual power of the headstock on the required diameter at the required speed is represented by the magnitude of the power value.

From this table a curve may be plotted for a series of diameters at any required cutting speed, the ordinates representing the power values and the abscissæ diameters of work. An example of such a curve is given in Fig. 5 relating to the headstock under consideration for cutting speeds of 40ft. per minute. The difference of power can be estimated at once from the chart. In cases where the speeds and gear ratios are badly arranged, the defects have their definite symptoms on the diagrams, and may easily be recognised.

Various curves for different cutting speeds may be plotted out to the same scale, and when comparing the relative values of two different headstocks for any given work, all that is necessary is to plot out the curves for both headstocks on the same diagram for the same cutting speeds and range of diameters, when any serious irregularities will be easily shown up.

A number of curves for different cutting speeds could be plotted on the same sheet, thus making the diagram a complete record of the character of the headstock for all the work it can handle at all reasonable cutting speeds. In the case of the headstock which has been taken as an example for this article, the various curves very nearly coincide, and the diagram would become too elaborate to be easily read. For this reason only one curve is shown. It will be noted that the curve descends as the diameters increase, which is natural and unavoidable, as it is on the smaller diameters that the power is always in excess no matter what may be the design of the headstock. When estimating the suitability of a given headstock for any work it is important to closely scrutinise the *minimum* power values, otherwise it may be found that the lathe is deficient in power on one of the most important jobs which it may have to do.

An indication of the uselessness of judging a tool by its maximum gear ratio may be found by referring to the table, from which it will be seen that the maximum gear ratio is never in use at all for cutting speeds above 42ft. per minute, and, therefore, has absolutely no bearing on the question of adaptability for high-speed steels, the use of the maximum gear ratio being confined on a bar lathe almost entirely to screwing, forming, and other operations which may have to be performed with tools made from other than high-speed steels.

The table and diagram which are given in this article are printed largely on account of their suggestiveness, and in order to remove what is a very common misconception as to the driving power of a machine tool. The writer appreciates the fact that a considerable amount of work is involved in the preparation of such diagrams, and that on this account they are not likely to come into very common use among machine tool buyers. At the same time, they offer a form of analysis of the character of machine tool driving mechanism which covers all variations of speed and diameter, and in a more complete manner than has hitherto been attempted.

We may now turn to the description of a number of lathes designed for high duty, and it will perhaps be fitting to deal first with the Hetherington headstock, for as probably many of our readers are aware, Mr. E. P. Hetherington has devised a method of measuring the power of lathes which differs almost fundamentally from Mr. Vernon's method.

Mr. Hetherington's method is to multiply the diameter of the large step cone by the width of the belt by the total gear, the result being called units of belt and gear effort. The figure thus obtained represents obviously the maximum power that can be got out of the headstock; it takes no account of the speed of cut. The only limit that Mr. Hetherington puts to the power of a belt-driven lathe is the speed of the cone pulley, which he fixes at 5000ft. per minute, which he considers the maximum safe peripheral velocity for cast iron pulleys. When this point is reached he adds to the belt width to get greater effort.

Mr. Hetherington's formula applied to several existing lathes gives very curious and anomalous results, and as might be anticipated, it shows that the machines made by his firm have great power. But after all is said and done we have to get back to belt power—that is, speed by width—for Dr. Nicolson has shown that about the same weight of metal can be removed per minute by a horse-power at all speeds within reasonable limits. A good formula might therefore be based on the contrast between the power represented at the spindle and the power put into the machine measured at the belt. Such a formula would show the mechanical efficiency of the headstock which would be lowest in most lathes when the belt was on the smallest pulley and the highest gear ratio in use. To the lathe user the great point to know is how many pounds of metal can be removed per minute per horse-power supplied at the different spindle speeds, and those figures could only be reached in the same way as we find the brake horse-power of engines, by actual test.

At the discussion of Dr. Nicholson's paper on "High Speed Steels," Mr. E. P. Hetherington maintained stoutly that the lathe was still in front of the steel, and a short time ago he kindly offered to demonstrate to us that he could destroy any steel on the market with his headstock, and there is not the slightest doubt that he can. We saw a number of high-speed tools by different makers tried, and as he drove a shaft of about ·48 carbon, with a fair dose of manganese in it—authorities differ as to its composition—at 100ft. a minute with over a $\frac{3}{4}$ cut and $\frac{1}{8}$ feed, it is not surprising that not a single tool held out for more than a few seconds. The headstock employed is illustrated by three views, Figs. 3, 4, and 6, and but little difficulty will be experienced in understanding it. It is driven by a constant speed belt, and in passing we may call attention to the fact that the loose pulley is somewhat smaller in diameter than the fast pulley. This is an old dodge for relieving the tension and consequent loss of power and wear on the loose pulley bush, but it is employed far less than it might be. The belt pulley drives through gearing on to an idler shaft, which drives the first wheel G, Fig. 6, of the headstock. On the spindle and a shaft parallel to it are four sets of wheels, A, all loose on their shafts, and brought into action by a sliding key in the usual way, moved by the hand wheel F, and three back gear wheels B, C, D, operated by clutches and the lever E. The clutches for the first pair are quite of the ordinary kind, that for the third wheel passes through the centre of the smaller wheel of the first pair, as shown in Fig. 8. Here it will be seen that A and C are brought into action by face jaws, whilst those for B are on the periphery of the clutch. Hence, by this pretty device, when A or C is in, B must be out, and *vice versâ*. Thus, one change is obtained on the idler, four on the nest of wheels, and three on the back gear, giving a series of twenty-four spindle speeds, and permitting of a speed of as much as 400ft. per minute on $8\frac{3}{4}$ diameter.

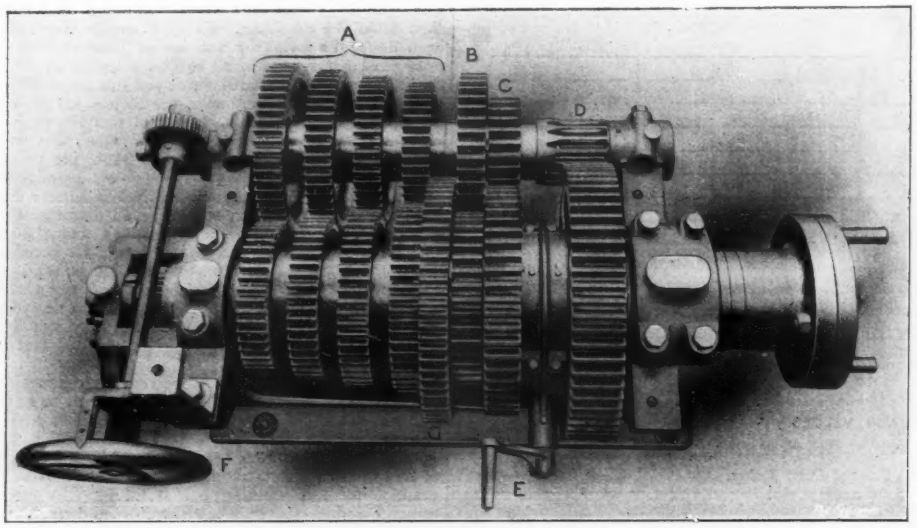


Fig. 6—HETHERINGTON'S HEADSTOCK

Such a cutting speed is never likely to be employed, and the useful limit is probably reached at 100ft. per minute, which can be obtained through twelve changes of gear on diameters from $2\frac{3}{16}$ in. to 14in. diameter. These are the high-speed gears. The twelve slower speeds for hard material or for finishing will go down to a speed of $12\frac{1}{4}$ft. per minute on a diameter of 14in. The spindle speeds are as follows:—3·42, 4·0, 4·69, 5·5, 6·81, 8, 9·4, 11·07, 13·65, 16·0, 18·75, 21·1 reducing speeds; 27·3, 32, 37·5, 44·2, 54·6, 64·2, 75·0, 88·4, 109·2, 128·4, 150·0, 176·8 high speeds. These speeds are, a moment's inspection will show, approximately in geometrical order.

Headstocks of this kind are being made in four sizes—viz., 10in., 12in., 14in., 16in. centres, and with front necks

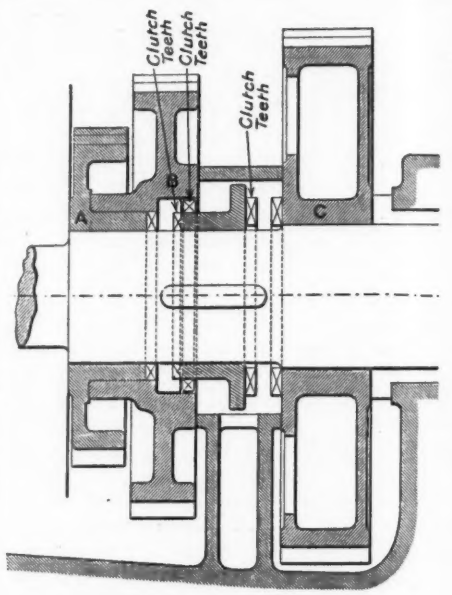


Fig. 8—HETHERINGTON'S TRIPLE CLUTC

5in., 6in., 7in., and 8in. diameter. The gears are for the great part cast iron, machine cut, but the last pinion is of steel, and the first on the belt or motor shaft when the latter is employed instead is of raw hide.

A consistent plan has been followed by the makers in the development of this headstock. They have been making for several years a very powerful headstock of the ordinary kind, but with enlarged cones, which they claim is as powerful as any ofthe new special headstocks built by other makers. They began with a lathe of this design and attempted to destroy it by fair work, but were unable to find a weak spot in the general design. Then the present special headstock was got out and was mounted on a lathe with a standard bed, slide rest, &c. A little trouble was experienced in the head with some pinions made of raw hide, but curiously enough the friction gear of the saddle was quite equal to the extra work put upon it, and practically the loose headstock was the only thing that needed modification. This would not hold up to the work, and the new bed which is illustrated by Fig. 7, and which gives an exceptionally good grip for the loose headstock, has been got out, and will be used in all lathes for the future. We may note here that it is the practice at Hetheringtons to design the lathes throughout on the height of centres as a factor; thus, for example, the depth of bed is always made one-half times the centres, as shown in Fig. 7.

The next machines we shall consider are two lathes by Hulse and Co., of Manchester, of which we are able to give, through the courtesy of the makers, some very instructive drawings.

Messrs. Hulse and Co., like several other firms, have appreciated the fact that whilst many managers do not care to go to the expense of whole new lathes, they are prepared to purchase new headstocks to be fitted on the old beds, and used with the old saddles and other gearing. They have, therefore, got out a new design of headstock, which they are either fitting to old or new lathes. It is illustrated by a set of drawings on page v., which show the construction as a whole plainly enough, but which are supplemented by further illustrations,

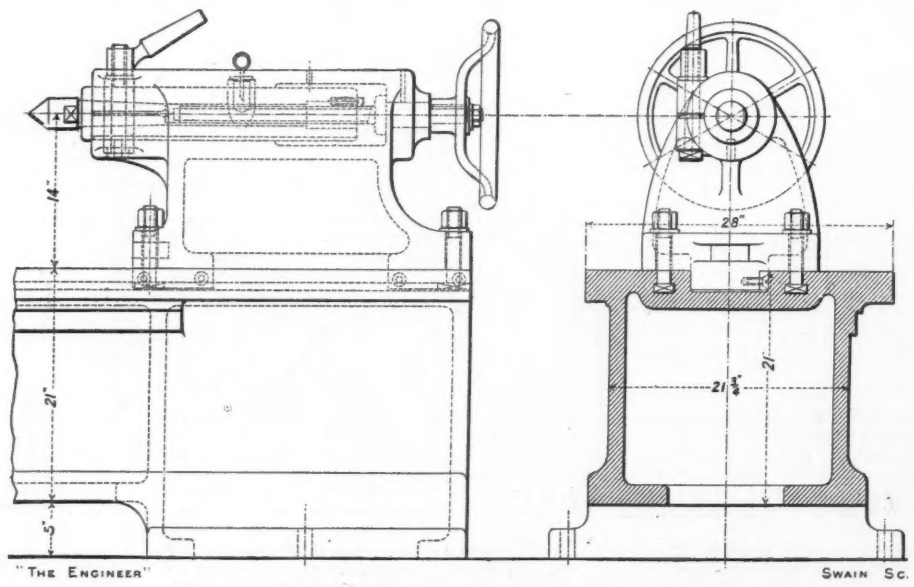
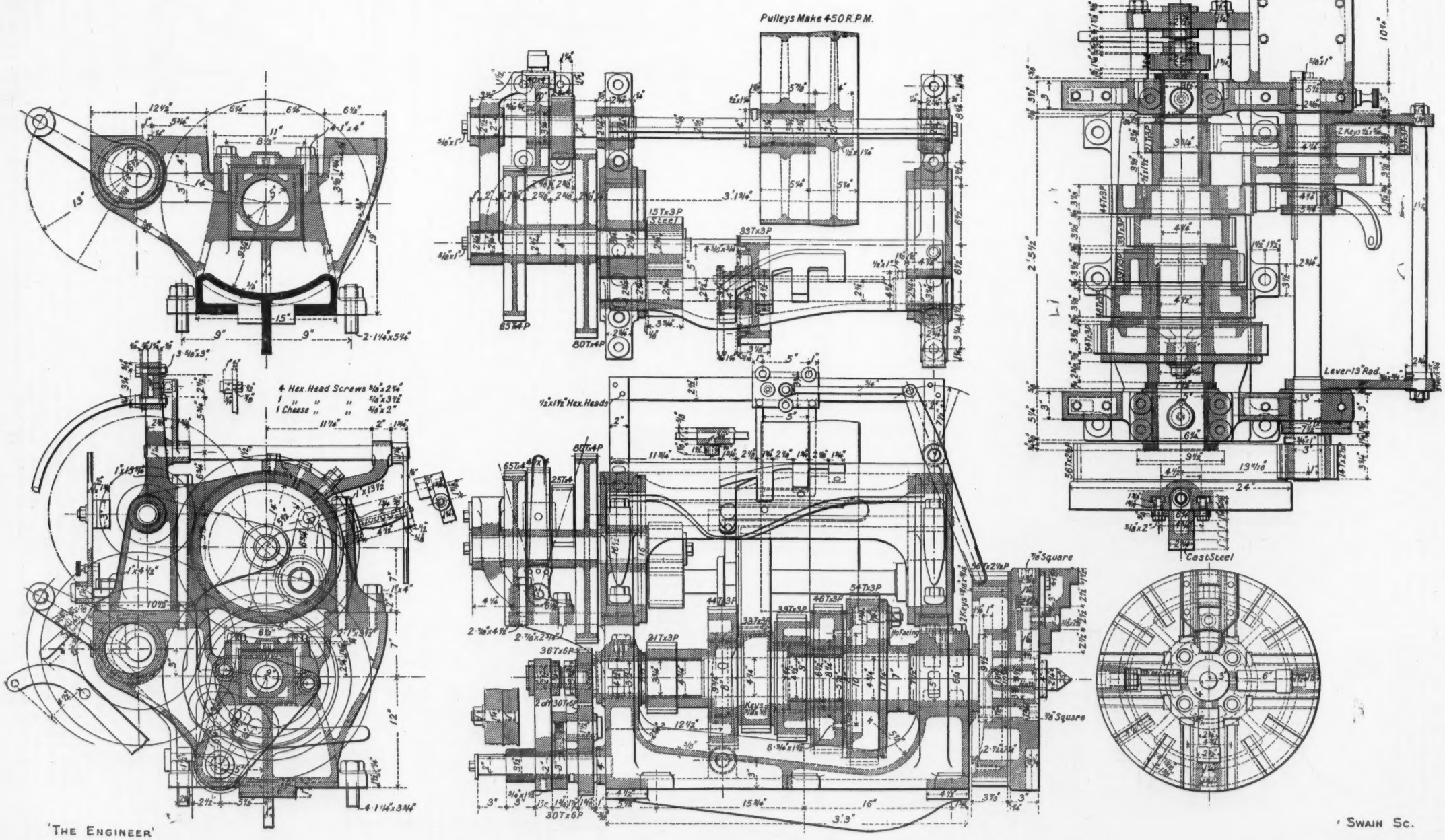


Fig. 7—LOOSE HEADSTOCK AND BED—HETHERINGTON AND SONS

12-INCH HIGH-SPEED HEADSTOCK

MESSRS. HULSE AND CO. LIMITED, MANCHESTER ENGINEERS



'THE ENGINEER'

SWAIN Sc.

which will render the neat method of changing speed more readily understood. It will be seen that an all gear head is used, and can be driven either by a fast or loose pulley, as in the drawings, or by a motor. It is arranged to run either in single or two treble gears, and a total of twenty-four different speeds with a constant speed countershaft is obtainable. Eight

through. A shaft mounted at the back of the headstock carries the fast and loose pulleys 2—Fig. 14 opposite—and two spur wheels of different diameters, 3 and 3*a*, capable of being brought into gear by sliding keys or by sliding as in the headstock illustrated on page v., with either of two wheels keyed to a second motion shaft, which is supported at its outer end by a fixed bracket, and at its

of which are explained by the legend, is an earlier design, and differs in several respects from that actually made and shown by the working drawings on page v. We think our readers will agree that this is a very neat arrangement, as the changes are readily effected, and all except those wheels actually in use are out of mesh. Driving on to the face plate at high powers has also, we

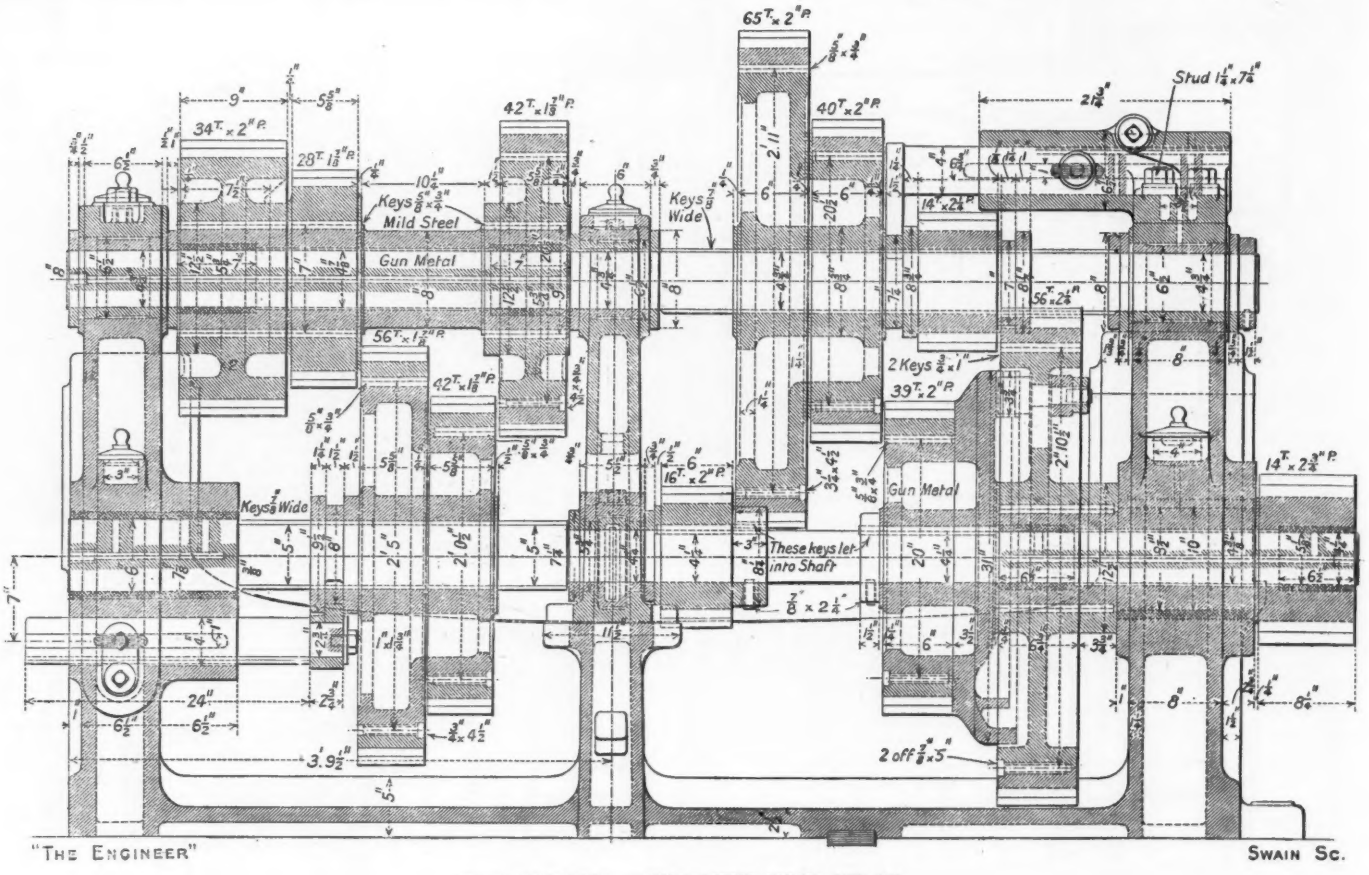


Fig. 9—HEADSTOCK, 30-INCH LATHE—HULSE AND CO.

of these speeds are obtained in single gear, and sixteen in treble gear, and they rise in geometrical ratio. Although the lathe is thus heavily geared, it has this great point in its favour that idle wheels are never running as in some other designs. An object well worth aiming at is the avoidance of the running of useless gears, both on account of the noise they make at the high speeds at which, under certain conditions, they must rotate, and also on account of the wear and tear that results.

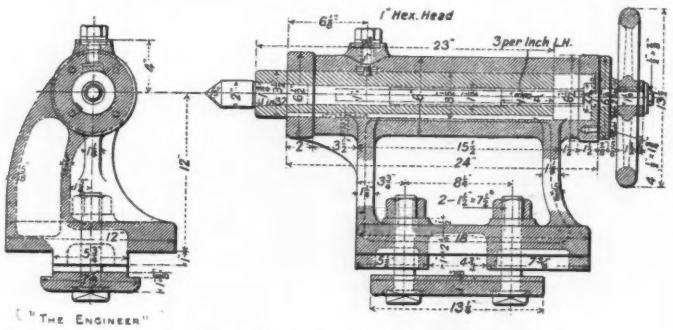


Fig. 10—12-INCH LOOSE HEADSTOCK—HULSE AND CO.

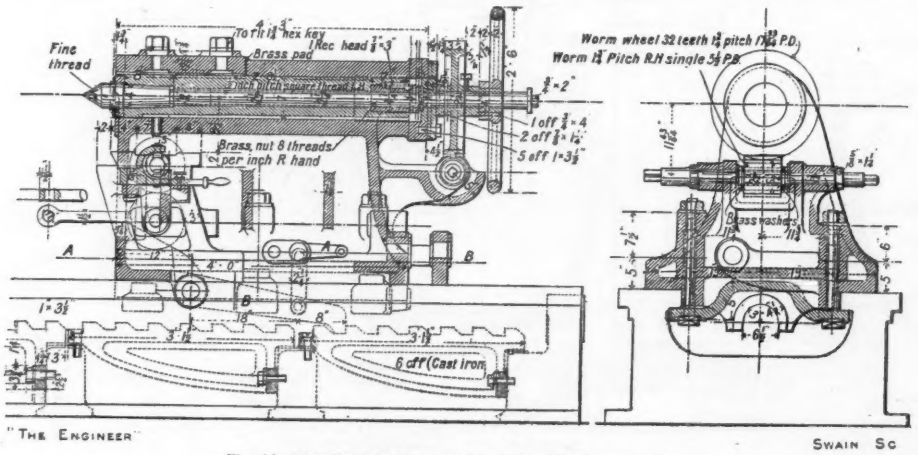


Fig. 11—30-INCH LOOSE HEADSTOCK—HULSE AND CO.

Let us now, by help of the figures, follow the gear inner end by one end of a frame or tube *h*, which can be rotated in the large diameter bearings 1*a* 1*a*. On the end of the spindle within the bracket is keyed a pinion 3*b*, which meshes with a pinion of the same size keyed on a third motion shaft, 3*c*, carried also in bearings in the tubular frame, but eccentrically. It will be at once obvious that the frame may be rotated about its centre, and yet these two pinions will always remain accurately in gear, one having a planetary path round the other. On the third motion shaft is mounted a spur wheel, *d* 1, free to slide, but not rotate, and capable of being brought into gear with any one of four wheels mounted on the main spindle, by suitable sliding and rotation of the frame *h*, a lever being provided for the former, and handle and catch plate or worm and wheel for the latter operation. By this method the eight single speeds mentioned above are obtained. They are doubled and trebled by sliding back gear of the ordinary kind driving direct on to the face plate, thus give a total of twenty-four changes—eight in single, eight in double, and eight in treble gear. It should be pointed out that the gear shown in Fig. 14, and the combinations

think, a good deal to commend it. Headstocks of this kind are, we understand from Messrs. Hulse and Co., being made in sizes from 10in. to 18in. centres, either in

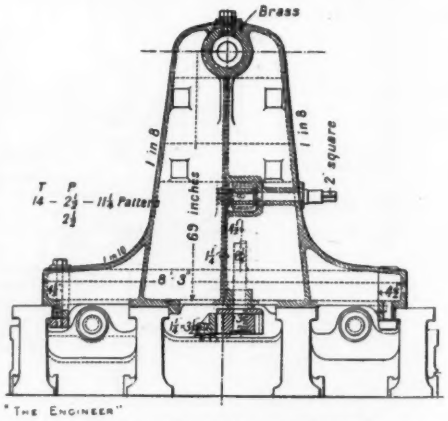


Fig. 12—LARGE LOOSE HEADSTOCK

combination with new beds, &c., or to fit on to existing beds. A type of back centre suitable for a 12in. lathe of this kind is shown in Fig. 10. It will be seen that the design

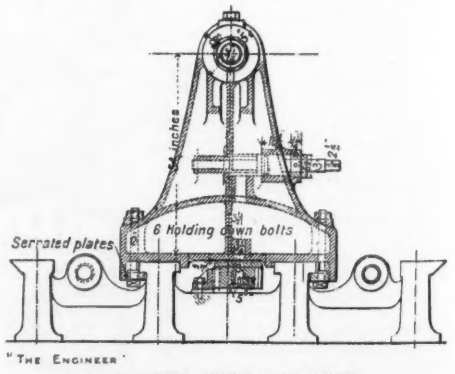


Fig. 13—LARGE LOOSE HEADSTOCK

permits of the use of very short bolts, as recommended in our opening remarks.

We illustrate also an exceptionally large lathe made by the same company for a firm of marine engine builders, and intended to use modern tool steels to their best

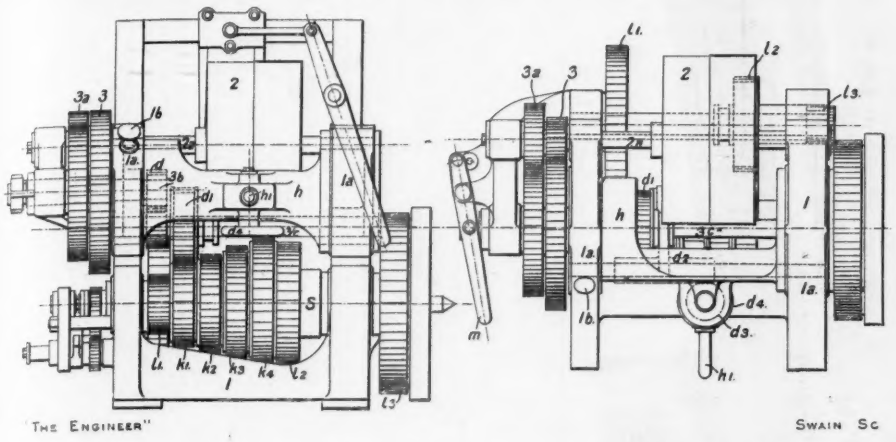
advantage on heavy crank shafts, &c. This lathe is of 30in. centre, and is an exceptionally fine and powerful tool, the gear wheels, with the exception of a few pinions, being steel rims machine cut from the solid on cast iron centres. Two motors are employed to work it, one of 60 horse-power for driving the headstocks, &c., and the other of 10 horse-power for the quick movement of the slide rests. The engraving on page viii., reproduced from a photograph, will give some idea of the massiveness of the design, but the drawings which Messrs. Hulse and Co. kindly allow us to reproduce will appeal more to the engineer, and will repay careful examination. The headstock is shown by drawings, Figs. 9 and 17, one of which exhibits the gearing, and the other, to a smaller scale, the manner of carrying the main spindle, which it will be seen is borne in independent bearings. The gearing provides for two changes in treble and four changes in quintuple drive, and is arranged to give a spindle speed of from 1 to 60 revolutions per minute. The changes are all effected by sliding the wheels, racks and pinions for that purpose being provided. A scheme of the gearing is shown in Fig. 15, where A stands for the raw hide pinion on the motor shaft driving the three wheels B, C, E, all in one piece, and revolving freely on a fixed shaft; the pair D and F are keyed to the driving-shaft, but may be slid along it into gear with either C or E. These are the first two changes. On the other side of the central bearings there are two changes with L K and M N and two with H G and M N in gear. The speeds, gear power, and combinations are set forth in the speed table below. L and M are locked together in the usual way when required.

The ample proportion of the bearings of this headstock are well shown by the drawing, which also brings out fairly well the care which has been taken to maintain effective lubrication. The lower shaft, which rotates, is provided with a ring lubricator for the centre bearing, syphon lubricators at the ends, and the bushes are oiled by counterbalanced cups, not shown in the drawing, fitted in the end of the shafts, and prevented from rotating with it by heavy knobs or weights below them.

The slide bed of this lathe is 59ft. 6in. long by 3ft. 9in. wide, and 21in. deep, in two lengths, with numerous cross girders. The loose headstock has a barrel or spindle 7in. diameter, actuated by a screw and worm, and wheel for forcing the centre into the work, and it is secured to the bed by holding-down bolts and keeps, whilst the thrust is taken by a rack fitted in the centre of the bed. It is fitted with a special rest for facing the ends of shaft. This loose headstock is seen in Fig. 11, which also shows a portion of the rack under the bed. The pawl B which engages with it is raised by the lever A. A link for coupling the headstock to one of the saddles for towing it along the bed is provided.

The lathe has two duplex sliding carriages, each having two transverse slides and screws operated simultaneously or independently from the front of the lathe. Each carriage has two compound top slide rests. There are variable self-acting sliding and screw-cutting motion obtained from a central shaft, and transmitted by cross shaft to rotating nuts on two fixed screws, one on each side of the bed. Feeds beginning at $\frac{1}{32}$, and rising as follows, are obtainable:—$\frac{1}{16}$, $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{7}{16}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, 1, 1¼, 1½, and wheels are provided for cutting 3 and 6 threads per inch. The central shaft, as well as being driven from the headstock by gearing, may be clutched into gear with a 10 horse-power motor, as already explained, for quick adjustment. Independent surfacing motions are provided for by swing frames and change gear carried at the back of each sliding carriage, and permit of the following variations:—$\frac{1}{64}$, $\frac{1}{32}$, $\frac{1}{16}$, $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$. A set of change worm wheels, which may be used on either carriage, is also provided for turning taper, and permit of a great number of changes between 1 in 51 to 1 in 3.

Another old Manchester firm which has turned its attention to the high-duty lathe problem is that of Messrs. Smith and Coventry. Two of their designs are illustrated on pages ix. and x. They have, it will be seen, not launched out into any novelty in design of headstock, but they have nevertheless succeeded by careful proportioning of the cone pulley and back gears to get excellent results. The engravings represent a 10¼ and 15¼ high-speed lathe. The former has a three-speed cone of large diameter, with small rise of step, and wide enough for a 3½ belt. The smallest cone is 10in. diameter, the other steps 13in. and 16in. It has single and double back gears, and thus gives with a two-speed countershaft a range of eighteen speeds. These, as will be seen from the diagrams in this column, are arranged in proper ascending order. The headstock has ample proportions for the work expected from it. The front bearing is 4in. diameter by 6in. long, and the back bearing is of the propeller thrust block type, the spindle being hollow. The saddle and loose headstock speak for themselves. The feeds are positive and are controlled by a lever in front. The lathe was photographed during a test on wrought iron. The cut was ⅜ deep with a traverse of ⅛ at a speed of 50ft. per minute. At the same speed, but with a feed of $\frac{1}{16}$in., a cut ¾ deep was taken in the same material.



1 is the fast headstock of a lathe
2 the driving pulleys
3 and 3a are two changes of spur gear
3b is the second-motion shaft
3c is the third-motion shaft
d are the spur pinions on 3b and 3c
d_1 the intermediate wheel adjustable along the shaft 3c by means of the clutch lever d_2 and rack pinion d_3, operated by hand wheel d_4
h is the tubular bracket rotated in the bearings 1a formed in the headstock 1 by the handle k_1, and held in position by the stop pin 1b
k_1 to k_4 are the four wheels on the spindle, into each of which the wheel d_1 may be put successively in gear, by the combined rotation of the tubular bracket h and the sliding of the wheel d_1 along 3c
l_1 and l_2 is one set of double gear as usually made
l_1 and l_3 is a second set of double gear as usually made
Handle m throws a sliding key into gear with either 3 or 3a
24 changes of speed can be got at the spindle s
4 changes through 3 and d_1 into k_1 to k_4
4 changes through 3a and d_1 into k_1 to k_4
4 changes through 3 and d_1 into k_1 to k_4 and l_1 and l_2
4 changes through 3a and d_1 into k_1 to k_4 and l_1 and l_2
4 changes through 3 and d_1 into k_1 to k_4 and l_1 and l_3
4 changes through 3a and d_1 into k_1 to k_4 and l_1 and l_3

Fig. 14—LATHE CHANGE SPEED GEARING—HULSE AND CO.

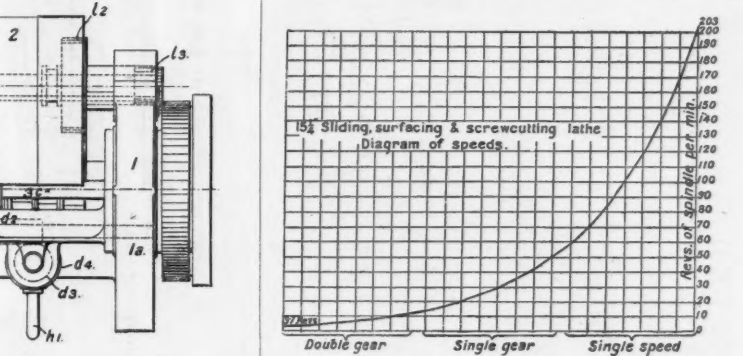


Fig. 16—SPEED DIAGRAM—SMITH AND COVENTRY

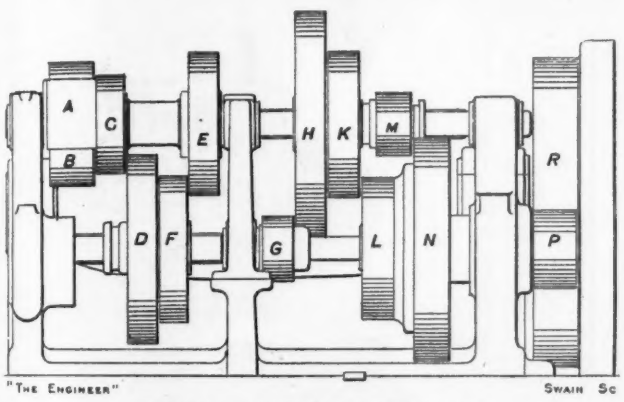


Fig. 15—GEAR DIAGRAM OF 30-INCH LATHE

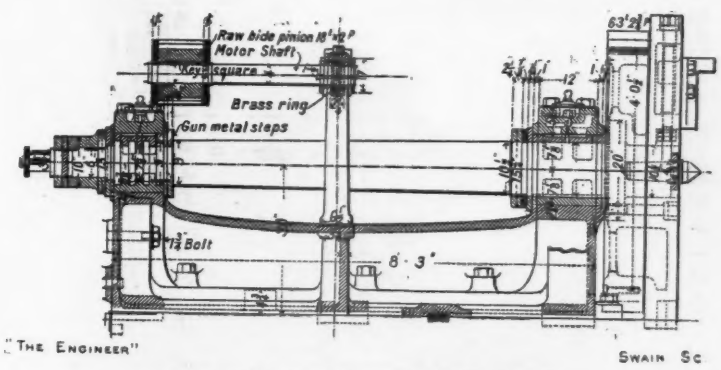


Fig. 17—MAIN SPINDLE, HULSE 30-INCH LATHE

Gear Changes and Speeds—Hulse 30in. Lathe.

Gear from motor	Wheels in gear	Gear power.	Motor running at the following revolutions per minute. 250	270	290	310	330	350	370	390	410	430	450	470	490	510
			Revolutions per minute of spindle.													
Fourth quintuple	$\frac{A}{B} \times \frac{C}{D} \times \frac{G}{H} \times \frac{M}{N} \times \frac{P}{R}$ =	267·75 to 1	·94	1·01	1·08	1·15	1·23	1·30	1·38	1·45	1·53	1·60	1·68	1·75	1·83	1·9
Third quintuple..	$\frac{A}{B} \times \frac{E}{F} \times \frac{G}{H} \times \frac{M}{N} \times \frac{P}{R}$ =	133·87 to 1	1·86	2·01	2·16	2·31	2·46	2·61	2·76	2·91	3·06	3·21	3·36	3·51	3·66	3·8
Second quintuple	$\frac{A}{B} \times \frac{C}{D} \times \frac{L}{K} \times \frac{M}{N} \times \frac{P}{R}$ =	69·74 to 1	3·58	3·87	4·16	4·44	4·73	5·02	5·3	5·59	5·88	6·17	6·45	6·74	7·03	7·31
First quintuple ..	$\frac{A}{B} \times \frac{E}{F} \times \frac{L}{K} \times \frac{M}{N} \times \frac{P}{R}$ =	34·87 to 1	7·17	7·74	8·32	8·88	9·46	10·04	10·61	11·18	11·75	12·33	12·90	13·47	14·05	14·6
Second treble ..	$\frac{A}{B} \times \frac{C}{D} \times \frac{P}{R}$ .. .. =	17 to 1	4·71	15·88	17·05	18·23	19·41	20·58	21·76	22·94	24·11	25·29	26·47	27·64	28·82	30
First treble	$\frac{A}{B} \times \frac{E}{F} \times \frac{P}{R}$ .. .. =	8·5 to 1	29·41	31·77	34·11	36·47	38·82	41·17	43·52	45·88	48·23	50·58	52·93	55·29	58·82	60

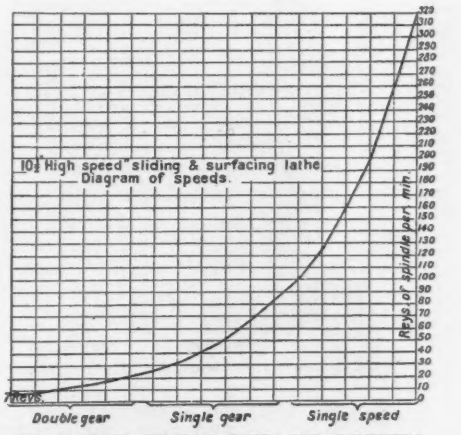
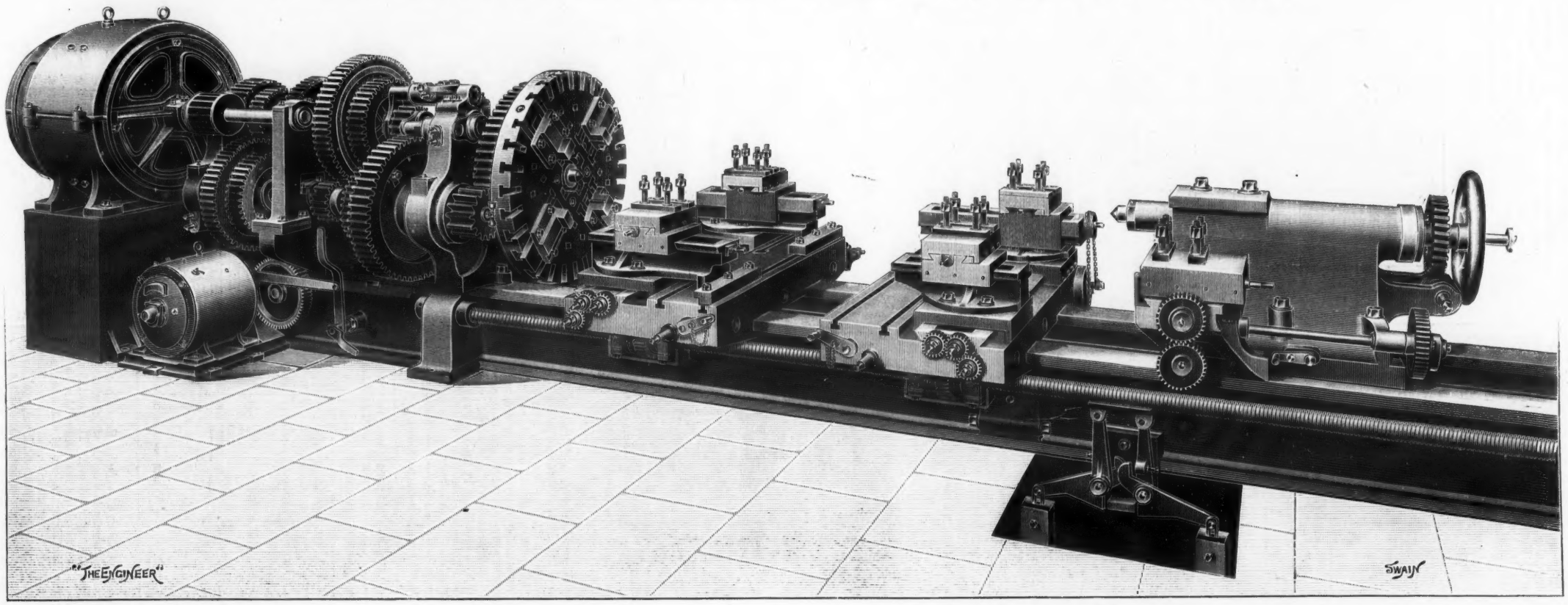


Fig 18—SPEED DIAGRAM—SMITH AND COVENTRY

30-INCH ELECTRICALLY DRIVEN LATHE—HULSE AND CO, LIMITED



The 15¼ lathe by the same makers is shown on page x. It is built on similar lines, but has a four-speed cone for a 4½ belt. The steps are 13in., 16in., 19in., and 22in. diameter, and by means of single and double gearing and a two-speed countershaft the regular range represented by the diagram, Fig. 16, is obtained. There are twenty-four changes in all. The front bearing is 5in. by 6½in., and the end thrust is taken by a tail pin. The feeds are positive, and the saddle and loose headstock are proportioned to take very heavy cuts. A fine turning taken on this lathe is illustrated by Fig. 25. The reduction was 2in., and the feed ⅛in. at a speed of between 45ft. and 50ft. per minute, or at a rate of about half a ton of turnings per hour, very good work for a lathe of the size and fulfilling the conditions of a long and regular range of speeds. The diagram illustrating the latter point speaks for itself; the revolutions per minute are measured vertically, and the various steps of the cone in single and double gear horizontally.

We have from time to time illustrated special lathes for high-speed work that have been got out by Messrs. Darling and Sellers, of Keighley, and our readers are therefore fairly well acquainted with the characteristics of this firm's designs. However, as it would be to leave this Supplement incomplete if no account of their double tier bed were given, we offer no apology for dealing with it again, and we illustrate four lathes of their make. To take these in order of size, the first—Fig. 27—represents a 9in. lathe driven by belt and double back gear. It has the same type of head as the larger machines, and the large diameter of the cone pulley will be noticed. The saddle is guided, as in all Darling and Sellers' recent lathes, by a narrow raised strip on the front part of the front shear, whilst the weight of the saddle, which in most lathes has of necessity to overhang somewhat, is supported by a face parallel to the surface of the shears but at a lower level. The whole arrangement is better brought out by the section of a 10½in. bed, which appears in Fig. 26. Here it will be seen the upper surface of the bed is altogether some 9¾in. wide, giving with the lower tier a total effective width of 1ft. 7½in., whilst the saddle is guided wholly by a raised portion only about 1½in. wide. The proportion of length of saddle to the width of this strip is so great that cross winding is practically reduced to zero. An elevation of this lathe is given in Fig. 28. It has double back gear like the smaller machine, and has cone pulleys of large diameter, and suitable for a 4in. belt. The main spindle bearing is 4½in. by 6½in., and the largest cone is 18in. diameter. A two-speed countershaft is generally used, and then eighteen changes of spindle speed are possible. The ratio of the gear—which, it is hardly necessary to say, is all machine cut—is 5 to 1 in fast and 10 to 1 in slow gear. There are four speeds, $\frac{1}{32}$, $\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{4}$, which are instantly obtainable, and wheels, and lead screw for screw cutting. Either positive or belt-driven feed is fitted. The saddle has all the arrangements that are expected in a modern design. The loose headstock has a spindle 3in. diameter in a sleeve 1ft. 9½in. long. It is held down by three bolts, two being in front, as close as possible to the front edge of the base, which is cut away to allow the saddle to be brought close up to the back centre even when the latter projects but a very short way from the headstock. A lathe of very similar design, but of 12½ centres, is made. We have, however, selected a 12½ sliding gap lathe for illustration, as it shows a useful but rather uncommon design. In this machine, Fig 19, there is one bed sliding longitudinally upon another, and the width of the gap can thus be regulated to suit the work. The headstock is of Darling and Sellers' ordinary pattern. The front bearing of the spindle is 5in. diameter by 7½in. long, and is of antifriction bronze; the steps, of which the largest is 21¼in. diameter, will take a 5½ belt, and the gearing has ratios of 6 and 12 to 1, giving the

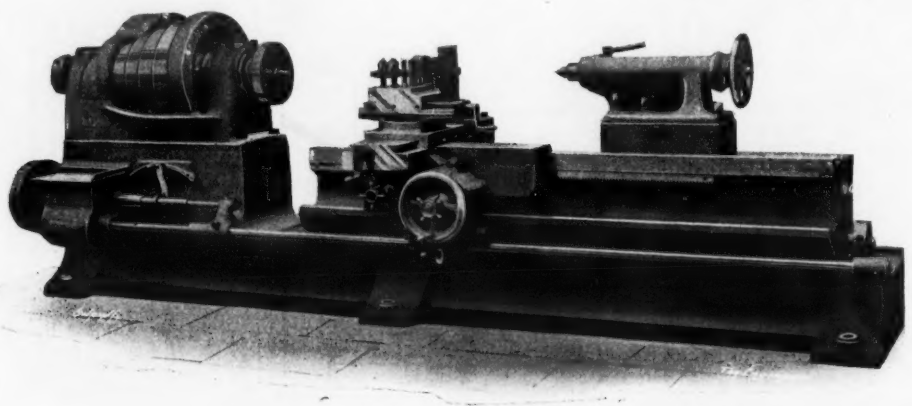


Fig. 19—SLIDING GAP LATHE—DARLING AND SELLERS LIMITED

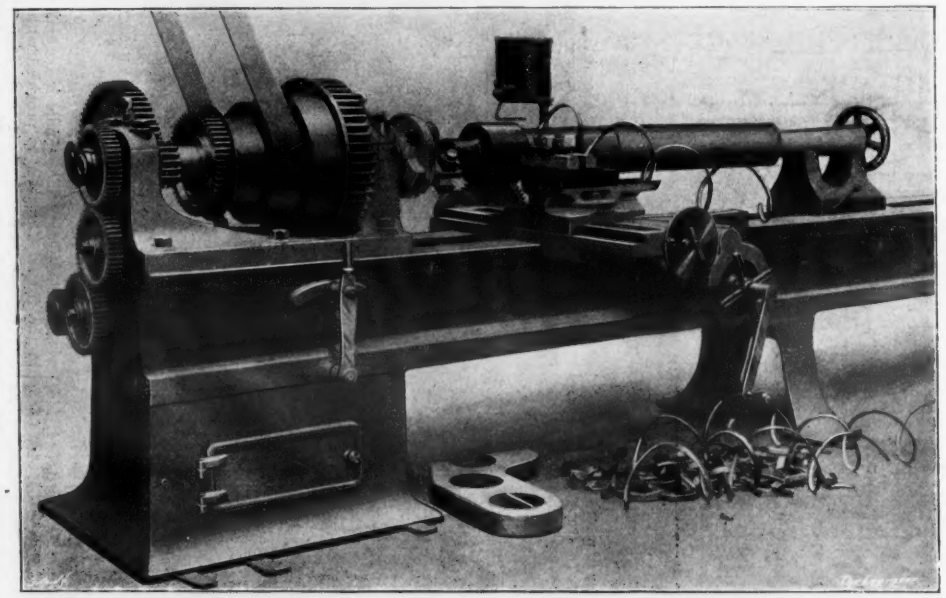


Fig. 20—10½-INCH LATHE—SMITH AND COVENTRY, LIMITED

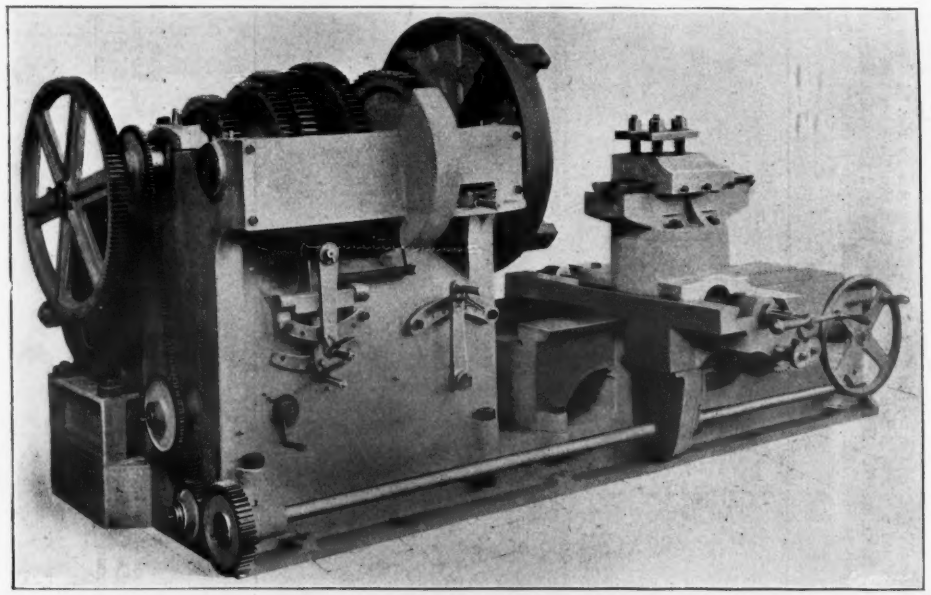


Fig. 21—24-INCH SURFACING AND BORING LATHE—J. BUCKTON AND CO., L MITED

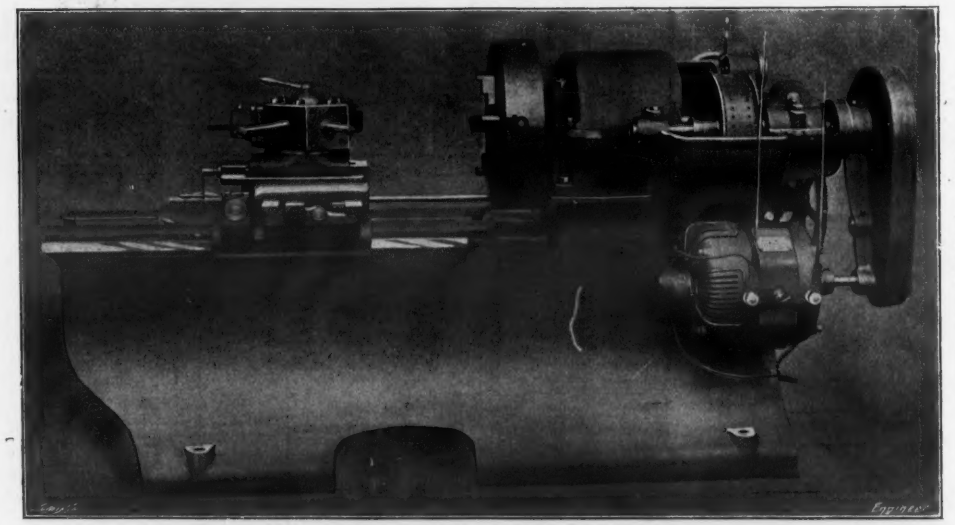


Fig. 22—SURFACING AND BORING LATHE—JOHN LANG AND SONS

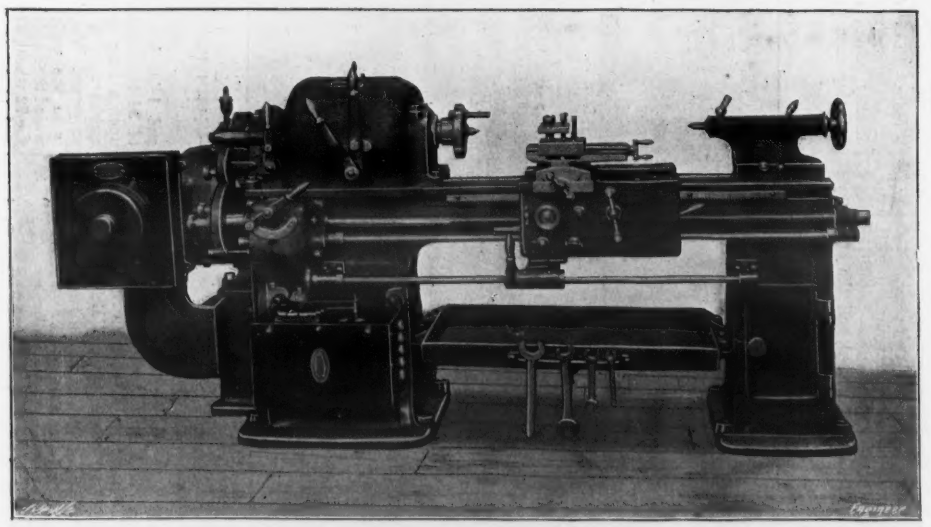


Fig. 23—6-INCH LATHE—DEAN, SMITH AND GRACE, LIMITED

lathe ample power for taking very heavy cuts. For each speed of the counter-shaft nine changes of spindle speed are obtainable.

An exceptionally fine lathe made by the same firm for the British Thomson-Houston Company, of Rugby, is illustrated on page i. We have already dealt with a machine of this size—18in. centres—belt-driven, but in this machine electric power is used, and the efficiency of the gearing has been proved by a series of tests made by the owners, and which are quoted below. The motor is a 20 horse-power variable double voltage, shunt-wound design, made by the British Thomson-Houston Company.

No.	Depth of cut.	Feed.	Cutting speed. Ft.	Amp.	Horse-power.
1	½	¼	40	33	21·45
2	½	1/16	80	36	23·4
3	½	⅛	80	54	35·0
4	¾	⅛	40	40	26·0
5	¾	1/16	80	45	29·25
6	1	⅛	80	70	45·5*
7	1¼	1/16	40	33	21·45
8	1¼	1/32	80	40	26·0

* Circuit breaker blew. Test very short.

These results are so exceptionally good that we have made special inquiries into the accuracy of the observations, and have reasons for believing the figures are quite accurate. The steel appears to have been about ·3 per cent. carbon. Running light, the lathe took 5 amp. at 500 volts, or about 3·3 horse-power. Attention may be directed to tests Nos. 3, 4, and 6. Of these the first and second showed a rate of cutting of nearly 30 lb. per gross horse-power per hour; and the third of over 40 lb. Unfortunately, the latter test was too much for the fuses, and it lasted a very short time, but an output of 30 lb. per hour per gross horse-power—that is, the whole power put into lathe—is, we believe, a remarkably high figure.

We may now consider the special type of headstock designed by Miley's Machine Tool Company, Limited, also a Keighley firm. The latest design of it in a 12in. size is illustrated by Fig. 29. It is, it will be seen, a neat modification of the separate spindle type, the step cone and one set of gear being mounted independently of the main spindle. In the drawing the cone spindle, for the sake of clearness is shown out of its correct position, which is directly behind and below the lathe centre. It has a four-step cone pulley, with diameters 9in., 12in., 15in., and 18in. by 5in. wide, driving a gun-metal pinion of 24 teeth gearing with a wheel of 72 teeth, mounted upon a long sleeve on the lathe spindle. The sleeve carries also a clutch and second pinion combined, as shown. When the gear is in the position illustrated the 24 pinion drives the 72 wheel, 32 drives 60, and 15 drives 54, which is keyed to the spindle, thus giving a total ratio of 20 to 1. In the other position of the change lever the clutch connects the sleeve to the 54 wheel, and so to the spindle; the drive being then through the 24 and 72 pair only, the back shaft being thrown out by an excentric action in the usual way. With a double-speed countershaft running at 400 and 500 revolutions per minute, the following spindle speeds are obtained:—10, 12·5, 16, 20, 25, 31, 40, 50, 66, 83, 106, 133, 166, 208, 266, 333. The spindle runs in gun-metal bearings. The front neck is 4¾in. diameter by 7in. long, the back neck 3in. by 5¼in.

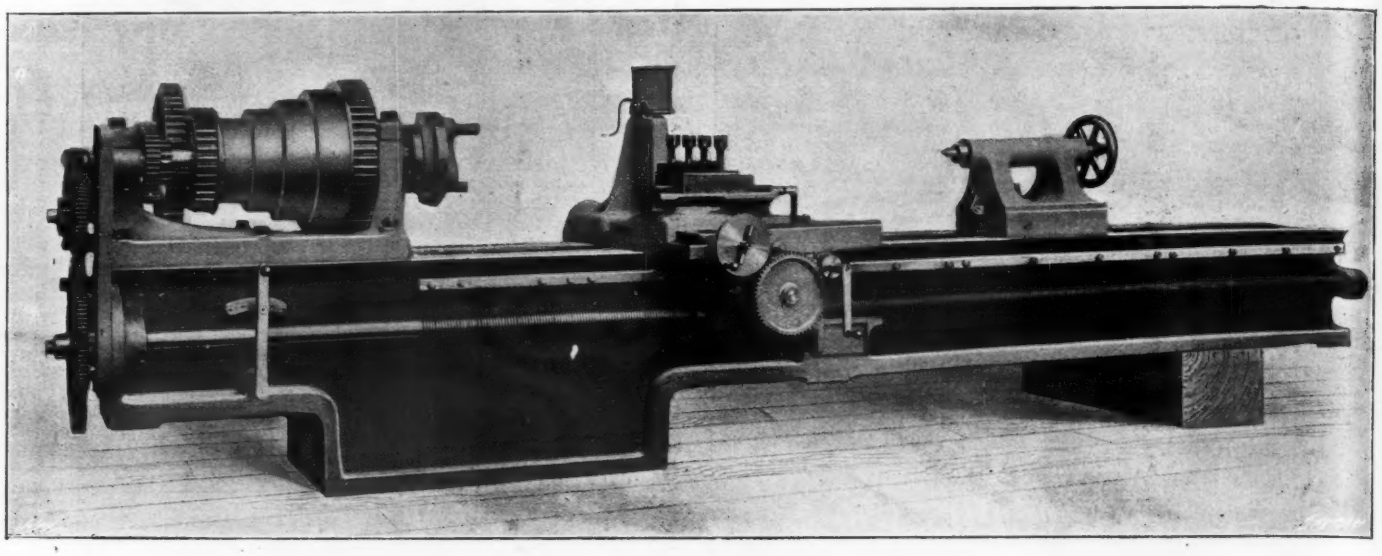


Fig. 24—15¼-INCH HIGH-SPEED LATHE—SMITH AND COVENTRY, LIMITED

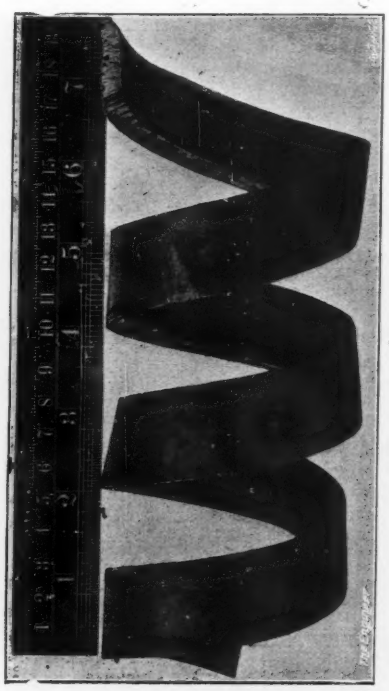


Fig. 25—TURNING FROM 15¼-INCH LATHE

We illustrate also lathes by another Keighley firm, Messrs. Dean, Smith, and Grace, who may claim justly to have been amongst the pioneers of the special high duty lathe, and to have given a great deal of attention to lathes of large size. A twenty-eight belt-driven lathe of their make is illustrated by drawings in our current issue, whilst the headstock is shown in greater detail by Figs. 33 and 34. It has a five-step cone, the smallest diameter being 18in. and the largest 30in., and takes a 6in. belt. The back gear is double, either the wheel E or G being slid into mesh with F or H, a lever with rack and pinion being provided for the purpose, whilst the excentric shaft is operated either by a lever as shown in one drawing, or by a worm and hand wheel as shown in the other. The spindle has thus fifteen speeds, with a single speed countershaft. They are uniformly graded throughout the whole range, running as follows:—2, 2·6, 3·4, 4·4, 5·7, 7·4, 9·4, 12·4, 15·8, 20·4, 26·4, 34, 44, 56·5, and 73 revolutions per minute of the spindle. The lathe, which is especially intended for turning heavy crank shafts, has a powerful four-jaw chuck bolted to the spindle. The latter runs in hard gun-metal bearings of which the front is no less than 10in. diameter by 14in. long. The thrust is taken by a tail-pin. The relative position of the cone spindle, back gear spindle, and main spindle is shown best by Fig. 34. The bed is of a very heavy design of a complete box section, 4ft. 6in. wide by 1ft. 8in. deep, the lead screw, 5in. diameter by 1in. pitch, square thread lying in a channel as shown by Fig. 36

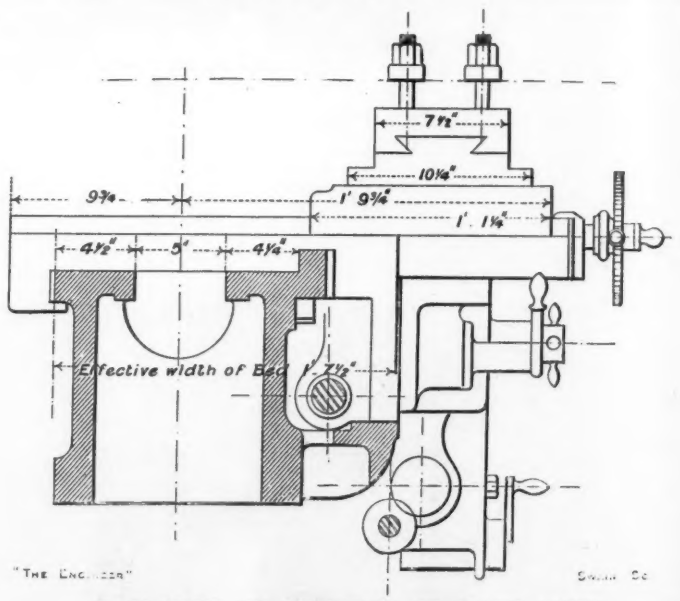


Fig. 26—DOUBLE TIER BED—DARLING AND SELLERS, LIMITED

This section shows also how the loose headstock is held down by bolts running in tee slots, very much as in the new Hetherington bed. Six bolts are got in by this design without difficulty. The elevation of the headstock—see the general arrangement—exhibits the stiffness of the design against thrust, and shows the arrangement for moving it by power or hand, and the manner in which the hand wheel for adjusting the spindle is brought conveniently to the front. The lathe is provided with four saddles, two of the ordinary kind and two at the back, made specially narrow for dealing with cranks. The latter pair is made of steel and securely bolted

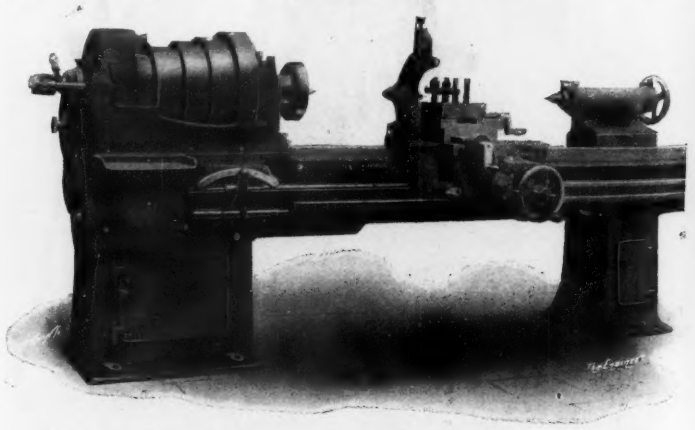


Fig. 27—9-INCH LATHE—DARLING AND SELLERS, LIMITED

to the base slide directly under the cutting edge. All the saddles can be manipulated from either side of the machine.

The feed shaft passes along the front of the bed and enters a gear-box, which permits of six changes of feed, as follows:—3, 4½, 6, 9, 12, and 18 cuts per inch. A development of the gear by which these changes are effected is shown in Fig. 35. The action is as follows:—On the end of the main spindle is a gear J, which meshes with K. Fastened to K is the gear L. Both gears, K and L, mesh with wheels on the shaft M, so that, with a sliding key working in the last-mentioned wheels, two different speeds are given to the wheels N, O, and P. These, again, mesh with wheels on the shaft Q, which also have a sliding key, and thus six different speeds can be given to the shaft Q and pinion R solid with it. The pinion R gives motion to two sets of reversing gears, one of which, shown at S in Fig. 33, gives through the shaft T all the surfacing feeds to the saddles, while the traversing feeds are obtained by means of a 5in. diameter screw, 1in. pitch, in the middle of the bed, driven by the other reversing arrangement before mentioned, and which cannot be seen on the headstock drawing. This arrangement permits the reversing of either feed independently of the other. The sliding keys are manipulated in the following manner:—The shaft U, Fig. 33, will slide inside the shaft Q, with which it revolves. A rack pinion worked by lever V meshes with a rack cut for some distance along the shaft U, which shaft also is connected to the sliding key, which may by this means be moved to the desired position. These changes are readily effected by hand wheels or cross levers provided for the purpose. All the gearing is neatly boxed in, and is operated entirely from the outside.

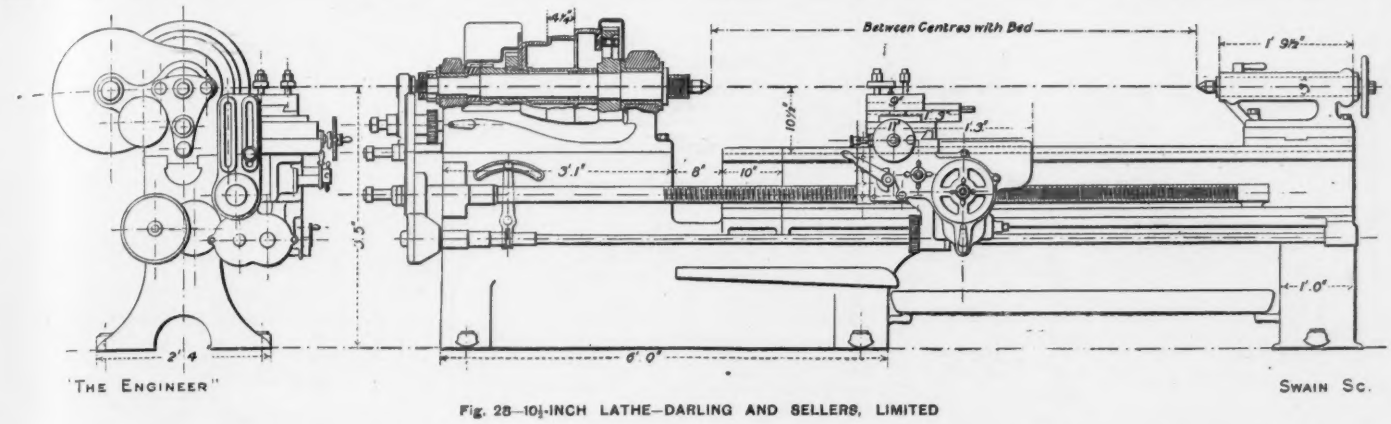


Fig. 28—10½-INCH LATHE—DARLING AND SELLERS, LIMITED

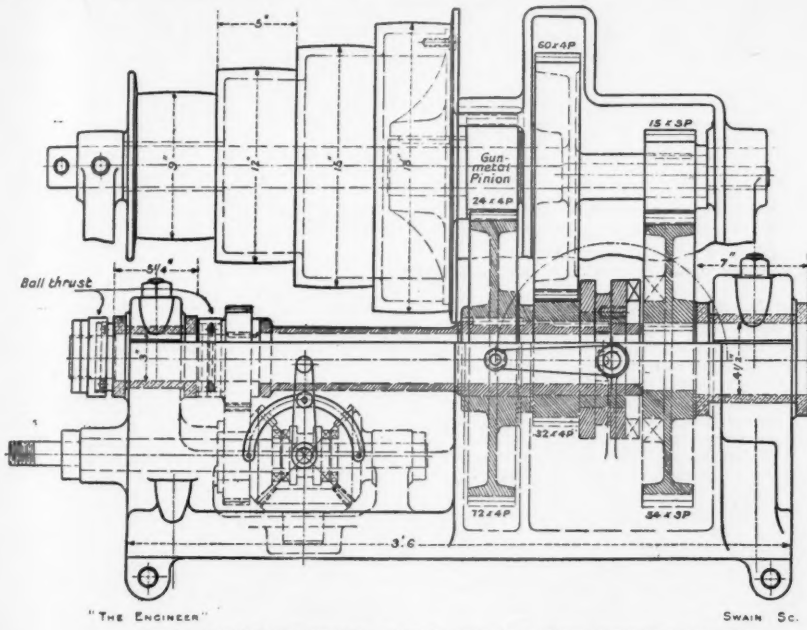


Fig. 29—12-INCH HEADSTOCK—MILEY'S MACHINE TOOL COMPANY, LIMITED

Messrs. Dean, Smith and Grace have also turned their attention to electrical driving, and have produced several interesting designs of all-gear heads, a particularly fine lathe having been supplied by them to the British Thomson-Houston Company. Unfortunately it has not been possible to obtain a satisfactory photograph of it and we are therefore unable to illustrate it. However, as an example of a neat design, we give a back and front view of a 16in. motor-driven headstock which they have already fitted to several lathes.

The spindle is driven by a 30 horse-power motor, placed on a stand at the back of the machine. The motor pinion is of raw hide; it meshes with a wheel on an intermediate shaft, which has also another wheel keyed to it and gearing with a large wheel running loose on the main spindle. This last wheel, to which two others of smaller diameter are fastened, takes the place of cone and pinions in a belt-driven machine. The double gear is engaged and disengaged in the usual way by means of an excentric shaft and lock bolt, and the pairing can be altered by means of a hand lever at the front of the headstock and a pair of sliding gear, A and B, Fig. 32, on the back excentric socket. The whole of the gearing is enclosed, as shown, in the hollow casting forming the headstock body, and is covered by a top guard which may be removed when required.

The motor is arranged to run at 300 and 900 revolutions per minute, and gives a complete and continuous range of speeds to the spindle of from 7·5 to 15·4 revolutions per min. Belt-driven lathes of this type have removed 16 cwt. of metal per hour with one tool, and it is believed that this all-gear head, with a 30 brake horse-power motor, should be able to exceed this amount.

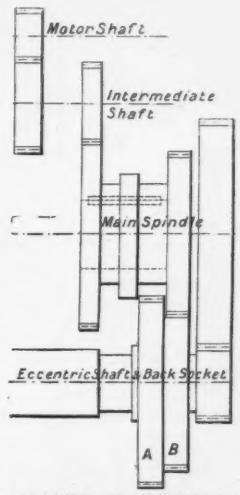
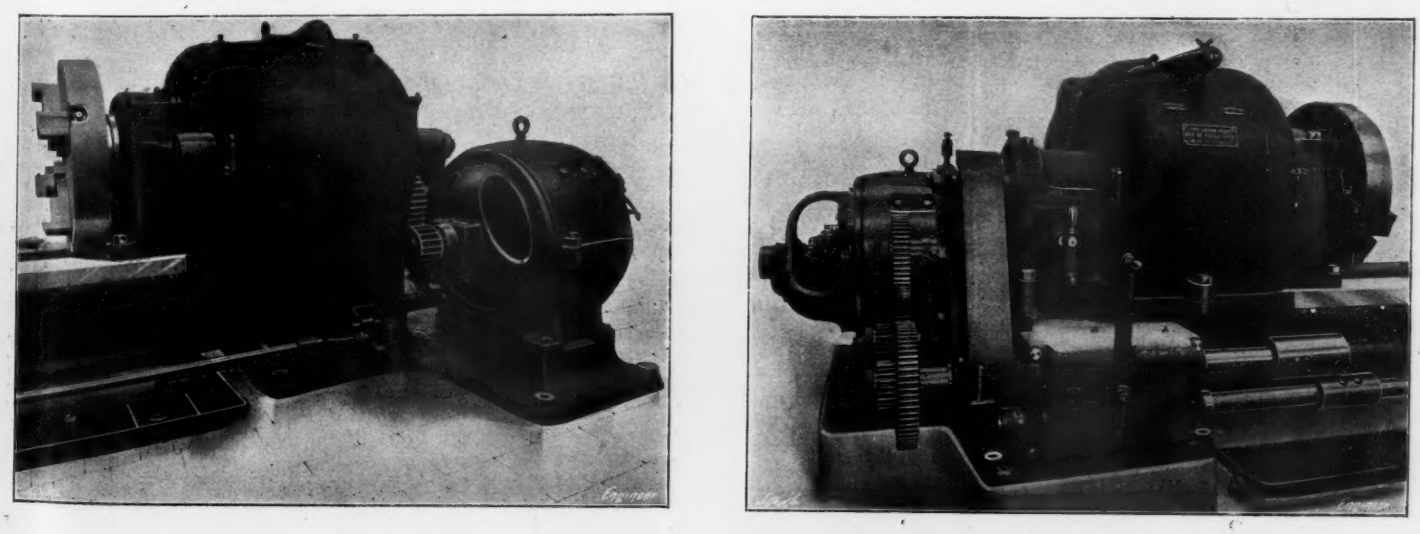


Fig. 32—GEAR, 16in. HEADSTOCK

The original bed has been improved in several respects. In the latest designs it has square in place of dovetail edges, which is quite in accordance with the best modern practice, and in order to avoid cross winding, and to give greater power to the feed, two racks are fitted one on each side of the machine. The width across the face of the shears is 2ft. 6in., and the depth of the bed 1ft. 6in. The loose headstock has a spindle 5in. diameter. The feeds are self-acting at 4, 8, and 16, or 8, 16, and 32 cuts per inch. This lathe was made for William Beardmore and Co., Limited, to the instruction of their manager, Mr. Chisholme, and is used for turning destroyer shafts.

The same makers have also given attention to quite small high-duty lathes, and a 6¾in. all-gear electric lathe by them is shown in Fig. 23. The motor is mounted on a large projection of the pedestal at the back. Attention may be directed to the method of manipulating the motor switches from the apron. The headstock has four changes of gearing, completely enclosed, and operated by means of two handles in front of it. The speed ratio of the motor and spindle are:—20, 9·5, 4·8, and 2·2 to 1, giving with a variable speed motor, running, say, at 300 to



Figs. 30 and 31—16-INCH MOTOR DRIVEN HEADSTOCK—DEAN, SMITH AND GRACE, LIMITED

800 revolutions per minute, a complete range of single speeds from 15 to 360 revolutions per minute. The front neck is 3in. diameter by 4½in. long, and the back neck is of the 12in. lathe is of steel, with front neck 5½in. diameter by 7½in. long, running in gun-metal bearings. The belt cone has four speeds of the maximum diameter of 24in., locking motion to its spindle. The feed shaft is carried on the front of the bed, and all the feed gear in the saddle is enclosed in a box apron. The screw-cutting motion, when

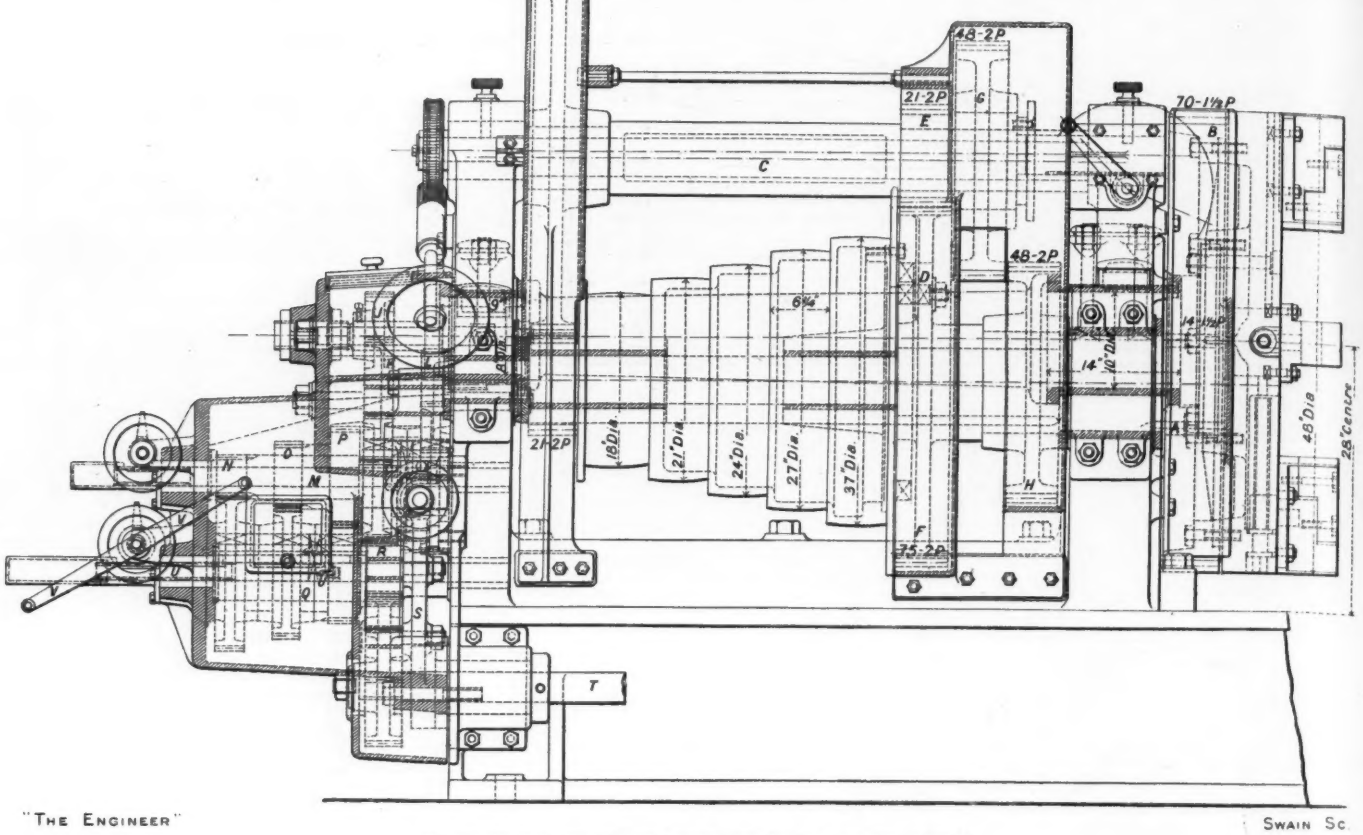


Fig. 33—28-INCH HEADSTOCK—DEAN, SMITH AND GRACE, LIMITED

2½in. diameter by 3½in. long. The bed, which has square edges, measures 12in. across the vees, and is 8½in. deep. The lead screw is 1⅝in. diameter, and the saddle is adjusted by means of a taper strip, and has safety interlocking motion, so that it is impossible for the feeds and the screw cutting to be engaged at the same time. The loose headstock has an extra strong base, being 11½in. long by 7½in. wide, and the spindle is 2in. diameter.

Several lathes, recently designed by Messrs. Joshua Buckton and Co., of Leeds, for using high-speed steels, are illustrated by Figs. 37 to 39. They have, if we may so express, a distinct personality, the making of the headstock and pedestal all in one piece for even such a small lathe as the 8in., the reversal of the usual position of the cone pulleys, and the general bluntness of the design being striking characteristics. There can certainly be no doubt about the substantiality of the main castings, the proportions erring, if anything, on the heavy side. The 8in. and 12in. lathes are in many respects similar.

suitable for a 5in. belt. There are two changes of gearing and a ring of gear upon the face plate, giving a total range of twelve speeds, uniformly graded in geometrical progression over the whole range, the changes of gear being effected by handles conveniently situated on the front of the headstock, and interlocked so that it is impossible to jam the gearing. There are eight changes of feed, operated by positive gearing arranged in eight uniform steps from $\frac{1}{32}$in. to ¼in., which can be instantly regulated without stopping the lathe by a handle conveniently situated on the front of the headstock. The saddle carries a compound slide rest with full swivel, and with automatic sliding and surfacing motion operated by the feed gear described above. All the feeds can be reversed in the saddle, and the longitudinal or slide feeding motion is actuated by rack and spiral pinion or multithread worm, which has always four teeth in gear, and gives a smooth motion entirely free from vibration. Quick hand motions are arranged for operating the saddle in all directions.

The saddle also carries a massive travelling stay fitted with three adjustable hardened blocks suitable for work up to 6in. diameter, this stay being made specially strong to withstand the thrusts of heavy cuts at high speeds. The loose headstock is a hollow box casting, capable of transverse adjustment by screw for taper work, and has a steel

fitted, consists of a leading screw, carried on the front of the bed, and provided with an extra long bronze disengaging nut and the necessary set of change wheels. This

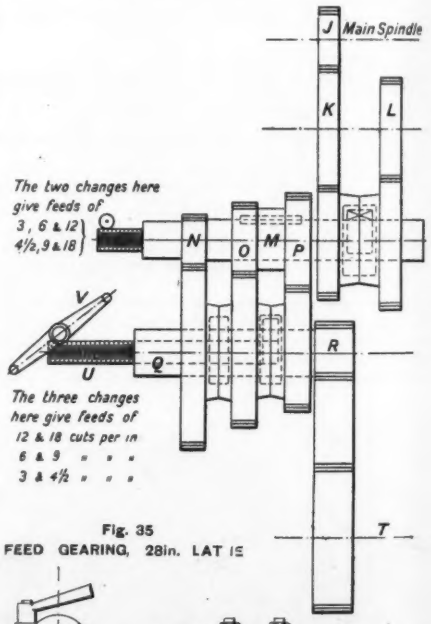


Fig. 35
FEED GEARING, 28in. LATHE

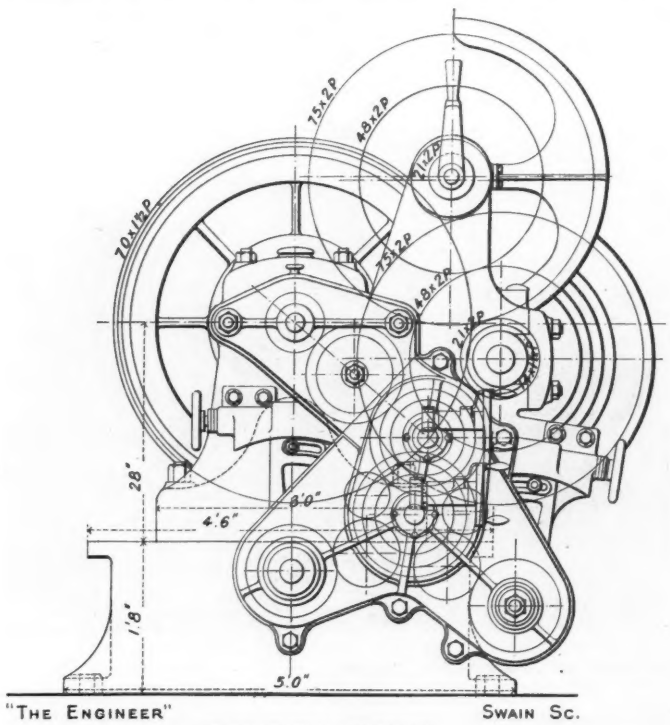


Fig. 34—28-INCH HEADSTOCK

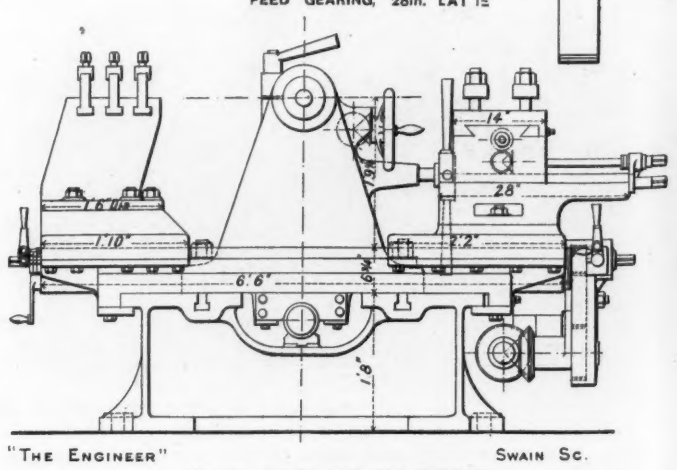


Fig. 36—28-INCH BED AND SADDLES

The headstock, as already noticed, is continued clear down to the ground, and it thus forms a box casting, containing and protecting all the driving and feed gears. The spindle spindle 3½in. diameter, with adjustment by screw and hand wheel. It can be gripped to the bed at any portion of its length by four bolts, and is fitted with a lathe will take a cut ½in. deep, with ½in. traverse, on forged steel, 6in. diameter, at a cutting speed of 60ft. a minute. It will swing 24in. diameter over the bed, 16in. over the

saddle, and is speeded to turn from ¾in. to 14in. diameter at 60ft. a minute, and when operating on steel forgings will easily remove material at the rate of 15 lb. per minute.

The 8in. lathe has practically the same arrangement,

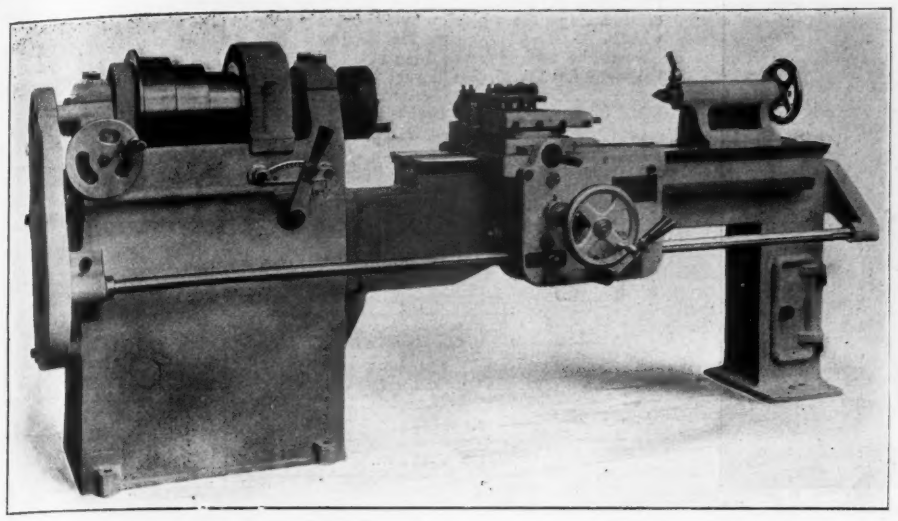


Fig 37—8-INCH HIGH-SPEED LATHE—J. BUCKTON AND CO., LIMITED

except that the last gear is not on the face plate; in it, as in the 12in., the sliding feed is effected by a rack and spiral pinion or multithread worm. It is a particularly handy tool, because not only can the starting, stopping, and reversing of the feed gear be effected on the saddle itself, but also all the variations of feed are controlled on the saddle, so that the operator can regulate his feed without changing his position overlooking the tool.

We illustrate also a 24in surfacing and boring lathe Fig. 21, by this firm. It has an "all-gear" head, and is driven by an electric motor carried on a pedestal at the back of the headstock. The motor has a two to one speed variation, and the main changes of spindle speed are effected by handles brought to the front of the headstock and interlocked to prevent two sets of gear being meshed simultaneously. The feed, which, it will be seen, is chain driven, is regulated by a lever, also in front of the headstock. The speed gear will be understood rom the drawing, Fig. 38. It permits of eight changes. A raw hide pinion on the motor gears with the first wheel A. On the first motion shaft the two pairs of sliding wheels, B C and D E are mounted. They are moved by the two levers, one above the other, in front of the lathes, and can mesh with either F, G, H, or K, giving thus four

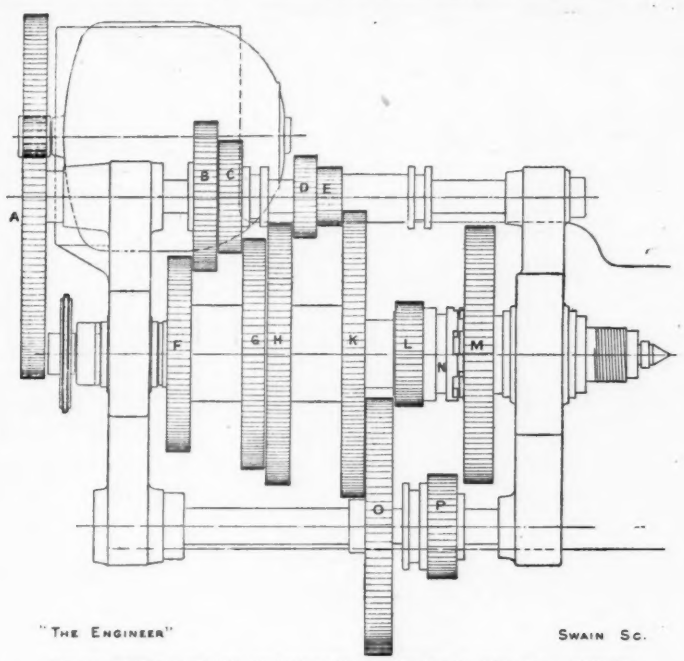


Fig 38—MOTOR DRIVEN HEADSTOCK—J. BUCKTON AND CO., LIMITED

speeds to the spindle, to which these wheels are coupled by the clutch N, operated by a horizontal lever, seen close to the face-plate in the external view. N may be moved out of gear, as shown in the drawing, or may be moved still further back, putting L into mesh with O, the action effecting this change sliding P into gear with M, when L, M, O, P act like an ordinary back gear, thus doubling the number of changes, and producing the eight required. The arrangement is very simple, and has the advantage that only the wheels actually required are in gear.

Another firm which has given close attention to the subject of high-speed lathes is the Tangye Tool and Electric Company, of Birmingham. We have, through the courtesy of the company, some interesting notes of the steps in design which have led up to the patterns now

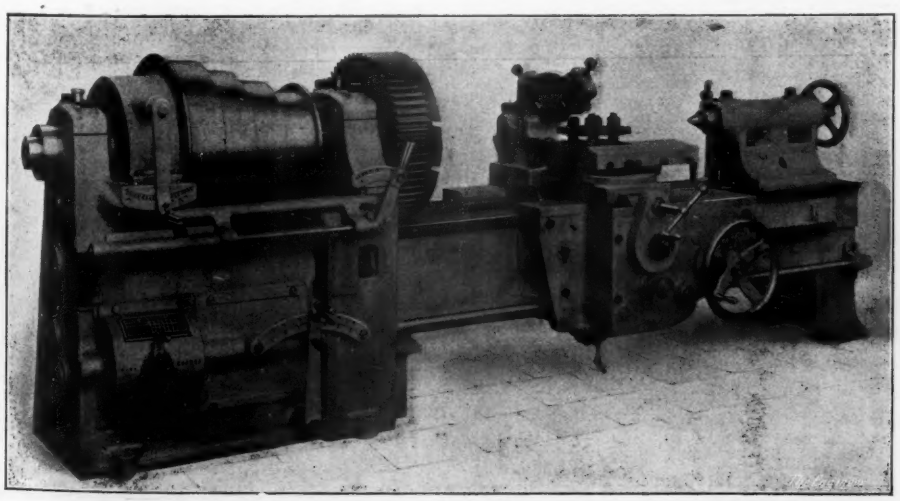


Fig. 39—12-INCH HIGH-SPEED LATHE—J. BUCKTON AND CO., LIMITED

adopted, and as they will be found useful and instructive, we do not hesitate to put them before our readers.

The company's first idea was to follow the beaten track, and use an ordinary headstock with cone pulley and double gearing; but it was soon evident that the necessary power could not be obtained in this way without such speed—revolutions per minute—of the cone pulley as would be too high for ordinary shop use; and, moreover, the belt speed was so great that it was feared the workman would shirk making the necessary changes to secure the correct speed for the tool. To obtain the power, and, at the same time, keep down the revolutions per minute of the driving pulley, it was decided, therefore, to have a wide belt; but as this made a cone pulley out of the question, a single-speed pulley, with the changes in the headstock—or what is now called an "all-gear" headstock—was ultimately adopted. This arrangement also was the most suitable one for electric driving, and a 12in.

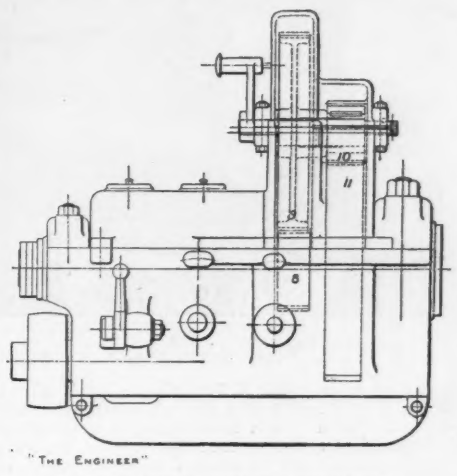


Fig. 40—TANGYE ELECTRIC HEADSTOCK

lathe was therefore made, with "all-gear" head and variable speed electric motor. This lathe was illustrated, along with a 16in. lathe, in our issue of July 24th, 1903. The next size taken up was a 24in. lathe, which, it may be interesting to recall, took the following cuts:

Test.	Depth of cut.	Feed per revolution of work.	Cutting speed. Feet per minute.
A	1in.	¼in.	32
K	1¼in.	¼in.	32
C	¾in.	¼in.	32
D	¾in.	¼in.	32
E	1in.	⅛in.	80
F	¾in.	¼in.	80
G	⅝in.	¼in.	80
H	½in.	¼in.	50

The company also made some 8in. lathes with all-gear headstocks and variable speed motors.

Following this, a series of lathes for high-speed cutting has been designed, with from two to three times the power of most ordinary cone pulley-driven lathes, which can be driven from a countershaft in the ordinary way, or by variable speed electric motor, connected either by

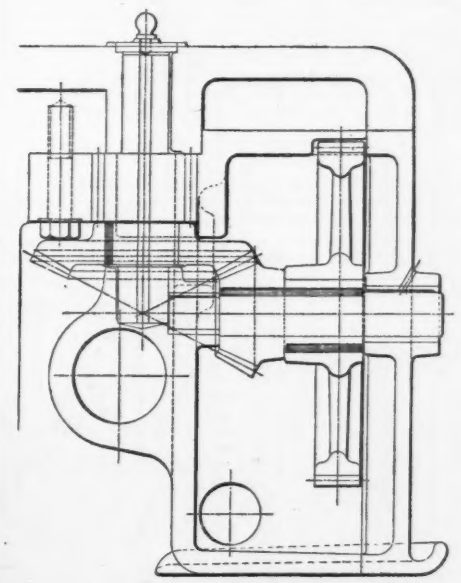


Fig. 41—SECTION OF APRON

belt or gear. In these lathes there are eight speeds in the headstocks themselves, and with an ordinary two-speed countershaft sixteen speeds are obtained, or where very small variation of speed is required, a four-speed countershaft is supplied. This gives a total of thirty-two speeds at equal increments, any one change of which can be obtained in less time than is taken to move a heavy belt from one cone step to another.

The illustrations, Figs. 40 to 47, and particulars of a 12in. standard high-speed lathe show the latest design which has been adopted for 8¼in., 10in., and 12in. sizes.

Commencing at the countershaft, it will be seen that there are two sets of pulleys, driven by belt in the ordinary way from the line shaft. These belts can be moved by

the usual lever. The additional two speeds are obtained through the gears shown and lettered A B and C D, Fig. 43. For the highest speed the pulley, running at 440 revolutions

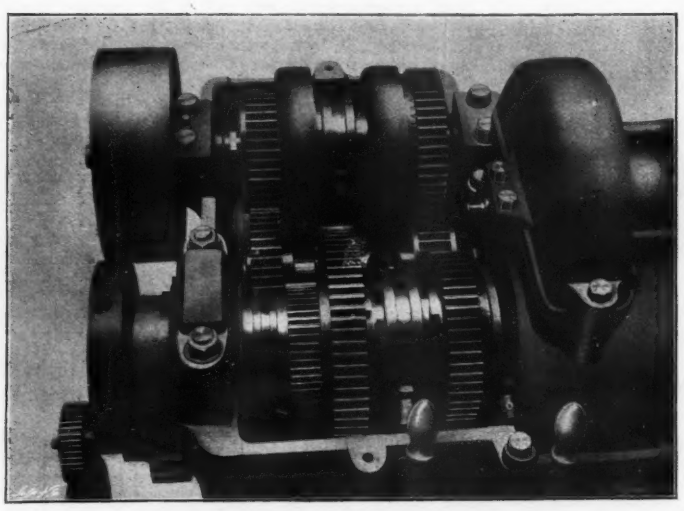


Fig. 42—12-INCH HEADSTOCK, COVER REMOVED

per minute, drives pulley X, from which a belt is taken to the lathe headstock pulley, through the equal wheels A B and friction clutch, thus driving it at 440 revolutions per minute. For the next slowest speed, the clutch lever is moved over to connect to wheel D, and this reduces speed of pulley X to 382 revolutions per minute.

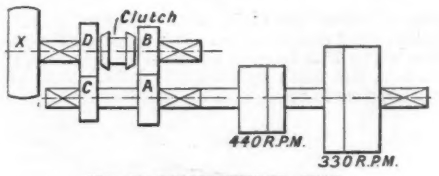


Fig. 43—COUNTERSHAFT GEAR

If too quick the clutch is connected to wheel B, and the belt is moved on to the fast pulley running 330 revolutions per minute, thus giving 330 revolutions per minute. The slowest speed is obtained by moving the friction clutch again into connection with D, giving 287 revolutions per minute. With a two-speed countershaft the speeds would be 440 and 330 revolutions per minute, and the pulley X would be keyed direct on it, the friction clutches and gearing

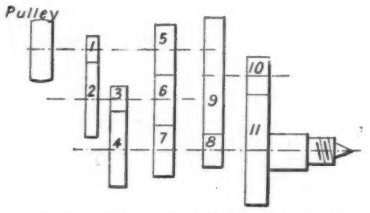


Fig. 44—GEARING OF 12-INCH HEADSTOCK

being omitted. Long bearings with ring oilers are used for this gearing to ensure perfect lubrication. The headstock gear should be fairly clear from the drawing, the eight changes of speed being obtained as follows, commencing at quickest speed :—

Countershaft pulley running at	Revolutions per minute.			
Through wheels.	Purchase.	440	382	330	287
A. 5-6-7	1·3 to 1	330	286	247	215
B. 1-2-6-7	2·4 ,, 1	183	159	137	119
C. 5-6 3-4	4·1 ,, 1	107	93	80	70
D. 1-2 3-4	7·4 ,, 1	59	51	44	39
E. 5-6-7 8-9 10-11 ...	12·7 ,, 1	34·6	30	26	22·6
F. 5-6 3-4 8-9 10-11 ..	22·9 ,, 1	19·2	16·6	14·4	12·5
G. 5-6 3-4 8-9 10-11 ..	39·2 ,, 1	11·2	9·7	8·4	7·3
H. 1-2 3-4 8-9 10-11 ...	70·6 ,, 1	6·2	5·4	4·6	4
		Revolutions per minute of spindle.			

The pulley is 20in. diameter, and carries a 5in. belt, this at the slowest speed, viz., 287 revolutions per minute, and assuming the moderate pull of 60 lb. per inch of belt, gives as the minimum power 13½ brake horse-power. The long bearings with oil rings employed for the pulley shaft should be noted. The friction clutch between wheels 1 and 5 is moved by a lever at the front of the headstock, and can be put into centre position to stop the lathe or into gear with either of the wheels 1 and 5 without stopping the pulley. The clutch between wheels 4 and 7 has claw teeth, as a friction clutch would not be advisable under the heavy load, but by manipulating the levers the claw clutches can be put in very quickly, and no disadvantage or delay results from this.

Wheels 8-9, 10-11, are used like an ordinary double gear, wheels 9 and 10 being on an excentric shaft standing on top of the headstock. When this gear is not in use, wheel 8 is moved endways by a lever, to bring its claw clutch into gear with the clutch on gear 11, and thus enable the combinations A, B, C, and D to drive the spindle, and arrangements are made so that the clutch cannot be put into gear until gears 9 and 10 have been thrown out, nor can 9 and 10 be put into gear with 8 and 11 until the clutch has been disconnected, thus preventing any possibility of breaking the gear wheels.

It will be noticed from the engraving, Fig. 47, that all the wheels are completely enclosed, although the gears 1 to 7 and friction clutches can be easily uncovered for examination or oiling by lifting off the light cover provided.

The spindle is of hard forged steel, carefully ground on the running surfaces, and is 6in. diameter by 7½in. long in the front bearing. The loose headstock, Fig. 49, is made heavier than is usual, having a spindle 4½in. diameter, and it is held down by three large bolts, the two in front

firms do not put in such a large loose headstock, but Tangyes are convinced that for really heavy cutting it is not a bit too heavy.

The feed motion is driven from the headstock by a belt of exceptional width, and as it runs at twice the spindle speed, there is ample power for all feeds required, while it provides a safety point in case of excessive strain.

The feed-box—Fig. 45—has a total of six changes, three being obtained by a slip key moved by the long lever; by moving the shorter lever over into the opposite

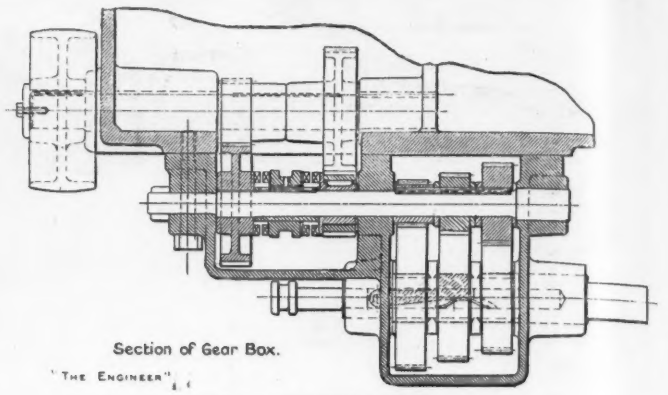


Fig. 45—TANGYE'S FEED BOX

clutch a second series of three is obtained. The feed may be varied to suit requirements, the pulley enabling this to be done quickly and cheaply, but the usual feeds are 4-6½, 10, 16, 26, and 40, or 6, 10, 15, 24, 40, and 60, if

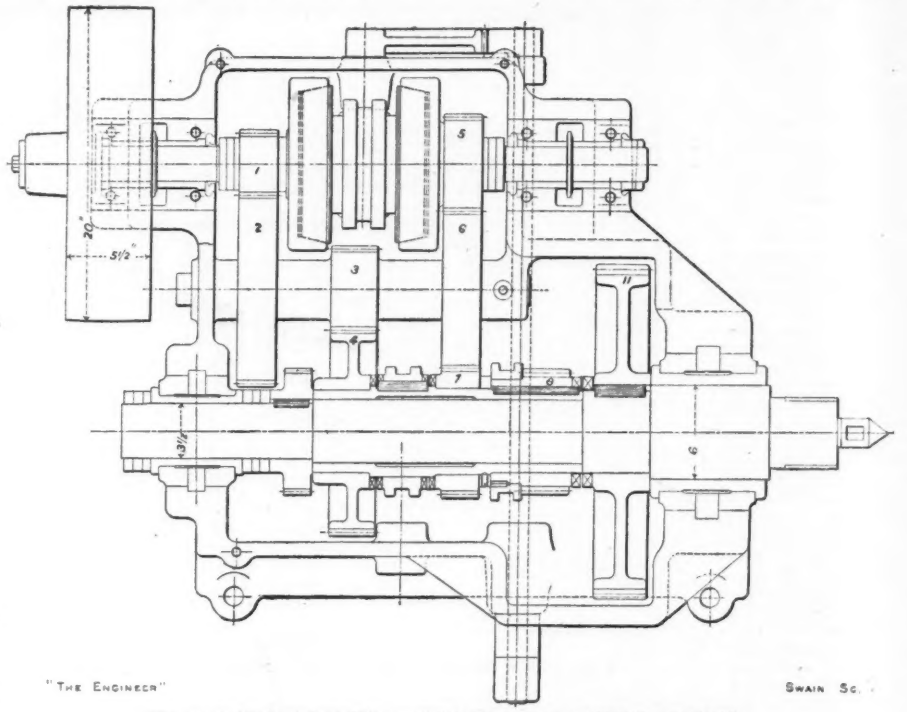


Fig. 46—12-INCH HEADSTOCK—TANGYE TOOL AND ELECTRIC COMPANY

very hard materials are to be turned. The section through the saddle—Fig. 41—shows the arrangement of rack and pinion, which gives the latter a bearing on each side, and prevents the deflection occasionally found in overhung

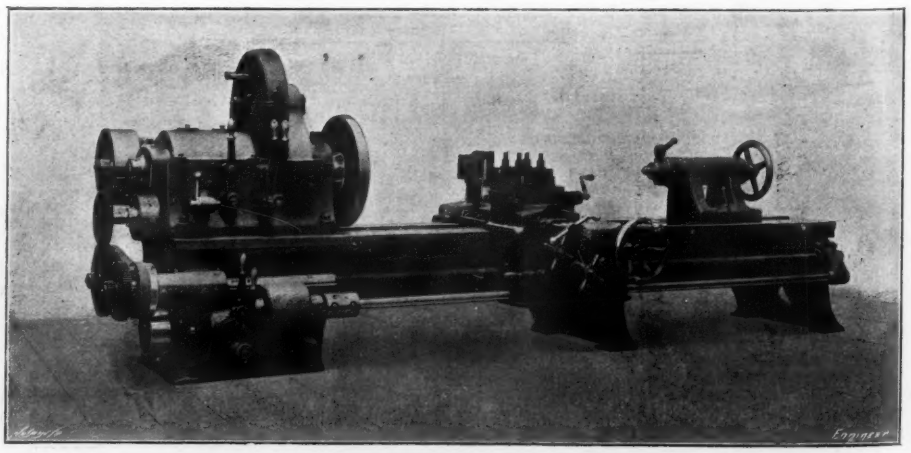


Fig. 47—12-INCH HIGH-SPEED LATHE—TANGYE TOOL AND ELECTRIC COMPANY, LIMITED

being arranged so that, although short to avoid stretching, they can both be used from the front of the lathe, the back bolt being placed higher to enable the spanner to pass over the front bolt—see Fig. 49. Many pinions, with consequent breakage of rack teeth. The racks and pinions are of forged steel.

The general engraving of the lathe shows a bed without gap, but these lathes are generally supplied with a gap,

and the table of speeds given is arranged for a gap lathe. Such a lathe will take work up to 42in. diameter by 12in. wide from the front of the face-plate, and the slow speed of four revolutions per minute is arranged to suit this, but it is not expected that the maximum power of the lathe will be required at this slow speed, although it will take a heavy cut on these large diameters.

not recommended, but, instead, a gear of the kind used in Tangyes' 24in. high-speed lathe, shown in our issue of Jan. 22nd, is employed. Fig. 48 shows this headstock and gear, and will give some idea of its great strength and power.

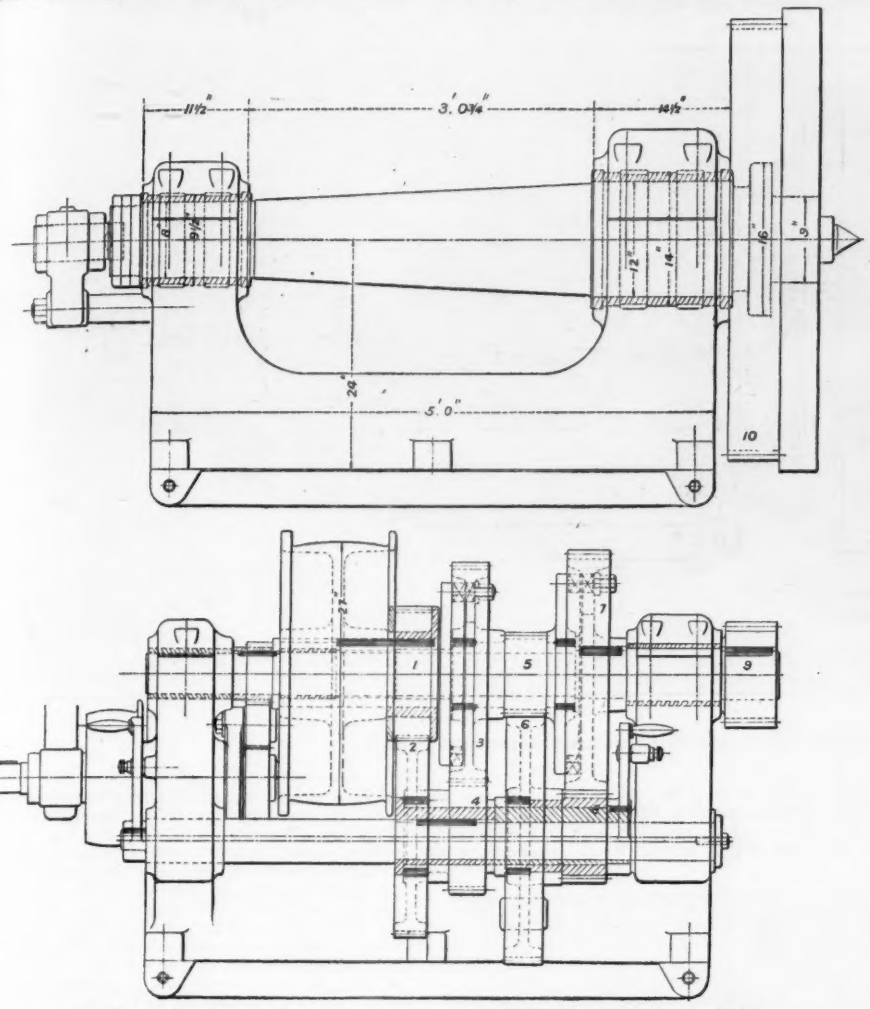


Fig. 48 -24-INCH HEADSTOCK—TANGYE TOOL AND ELECTRIC COMPANY, LIMITED

Electric driving with variable speed motors for these large lathes is preferred, owing to the great power required, but they can also be supplied with belt drive, using a four-speed countershaft similar to that on the 12in. already described. These have friction clutches to the belt pulleys, as the heavy belts required cannot be easily and quickly moved from one speed to the other. The gear is arranged as shown Fig. 48, the pinion 9 driving on to the face-plate.

Wheel 1 is keyed to the belt pulley, and for A is connected to wheel 3 by a lock bolt as used in the ordinary double-geared headstock. Wheels 3 and 5 are keyed together, and also connected to 7 by similar lock bolts. Wheels 2–4 and 6–8 are on separate excentrics, and are both thrown out of gear. When running in B gear the lock bolt at 3 is disconnected, and wheels 2 and 4 put into gear by means of an excentric. When running in C gear the lock bolt at 3 is connected, but that at 7 is disconnected. Wheels 2 and 4 are out of gear, but 6 and 8 are in. When running in D gear both lock bolts are disconnected, and wheels 2 and 4 and 6 and 8 are put into gear. Thus, using a variable speed electric motor having a range between 480 to 180, the following combinations are obtained:—

Through wheels.	Purchase.		
A. 9-10	4½ to 1 ...	106	to 40
B. 1-2-4-3 9-10	13¾ ,, 1 ...	34·8	,, 13
C. 5-6-8-7 9-10	41·85 ,, 1 ...	11·4	,, 4·3
D. 1-2-3-4 5-6-7-8 9-10 ...	128 ,, 1 ...	3·7	,, 1·4

The 16in. and 20in. lathes are made on similar lines, and can be driven from a countershaft by belting, or may be direct coupled to an electric motor, the latter being made of variable speed. Tangyes are at present making a special motor-driven lathe, 12in. centre, for testing high-speed tools, which has the above arrangement of headstock and gearing This lathe is to take a cut in forged steel ¾in. deep by ⅛in traverse at a speed of 75ft. per minute, and a motor to give up to 45 brake horse-power is being put in.

Some excuse is possibly necessary for introducing into this Supplement a brief description of the remarkable change speed headstock made by John Lang and Sons, of Johnstone, N.B., since it is not strictly speaking made for high-speed cutting; since, however, it aims at maintaining the correct cutting speed for all diameters of work, the speed rising regularly, and not by steps as in all other designs, its appearance is not wholly out of place amongst high-duty lathes. A general description of one of these headstocks appeared in our issue of January 29th last. In this Supplement we give a drawing of the gear and a view of a direct motor-driven 24in. surfacing and boring lathe, Fig. 22. In this view the machine is seen from the back, and part of the cover is removed to show the belt and one expanding pulley. The arrangement of this novel form of change speed gearing will be readily understood by inspection of the drawing, Fig. 50. Here M and N are respectively a fast and loose pulley, driven at constant speed by a belt or motor. M is keyed to a shaft carrying the expanding cone pulley A. The two parts of this cone are moved to or from each other by the cam C, actuated by a worm and wheel. The tension of the belt, of course, tends to force the parts of A asunder, and ball bearings are provided at each side of C, as shown, to take the thrust. A similar expanding pulley and cam, B and D, are mounted on another shaft. One worm shaft, worked by the hand wheel E, operates both pulleys, so that as one expands the other closes. Thus A may, by the use of a belt touching at its edges, be made to drive B at varying speeds. To B is keyed the pinion E, which, with F, G, and H, forms an ordinary back gear. Thus the shaft, and pinion J attached to it, may either be driven through the gearing when the clutch O is in one position, or direct when it is in the other position. To gain a further reduction, J drives the wheel K keyed to the main spindle. By this arrangement a very regularly graduated feed can be obtained. The maximum ratio of each expanding pulley is 3 to 1, giving a total range of speed equal to 9 to 1. The single gear ratio is 3·9 to 1, and in treble gear it is 26·9 to 1. Thus, through the former spindle, speeds from 25·6 to 230 revolutions per minute, giving a constant cutting speed of 30ft. per minute on all diameters between ½in. and 4½in. diameter are given. Through the latter—that is, treble gear—spindle speeds between 3·7ft. and 33·4ft. per minute are obtained. These would give the same cutting speed for all diameters

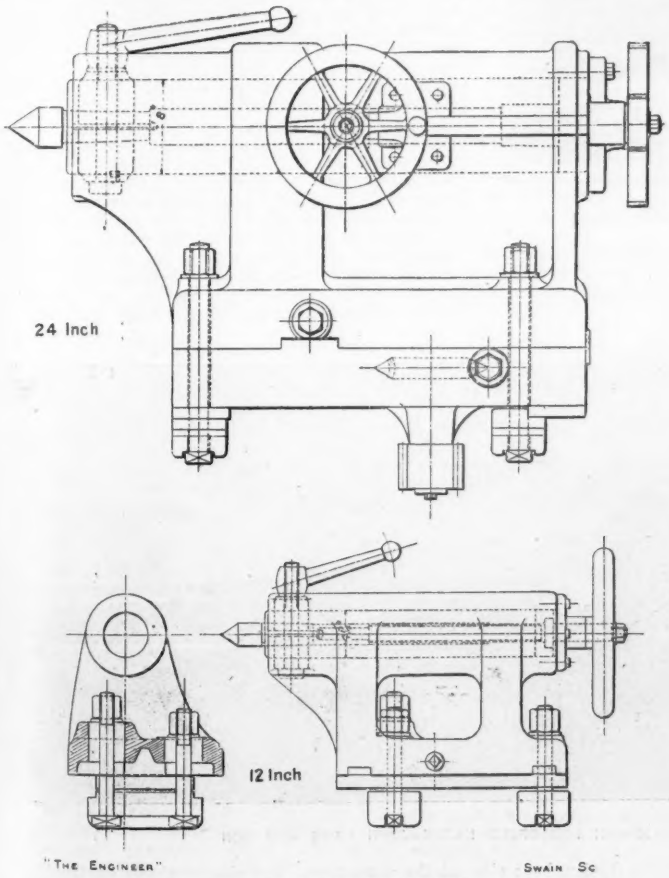


Fig. 49—TANGYE LOOSE HEADSTOCK

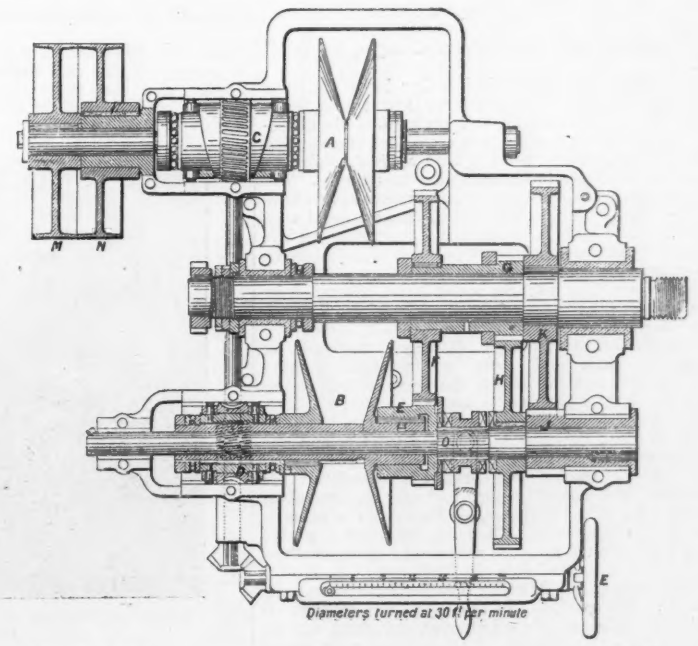


Fig. 50—LANG VARIABLE SPEED GEAR

An 8½in. capstan rest lathe of similar type, has taken cuts of 100ft. speed by ¼in. deep by $\frac{1}{16}$ traverse, and 135ft. speed by ⅜in. deep, same traverse, on mild steel bars.

Above 12in. centres, the arrangement described above is

between 3½in. and 31in. diameter. There is, it will be noticed, a certain amount of overlapping of speeds, but since the great majority of work on surfacing and boring lathes is on diameters between 3½in. and 30in., necessitating the use of the treble gear, less changes are involved by including the smaller limit, as well as the higher, in the triple ratio. Again, where the headstock is used on sliding lathes, as the diameters most frequently turned are between ½in. and 4½in., it is convenient to be able to reach the 4½in. speed without changing into treble gear.

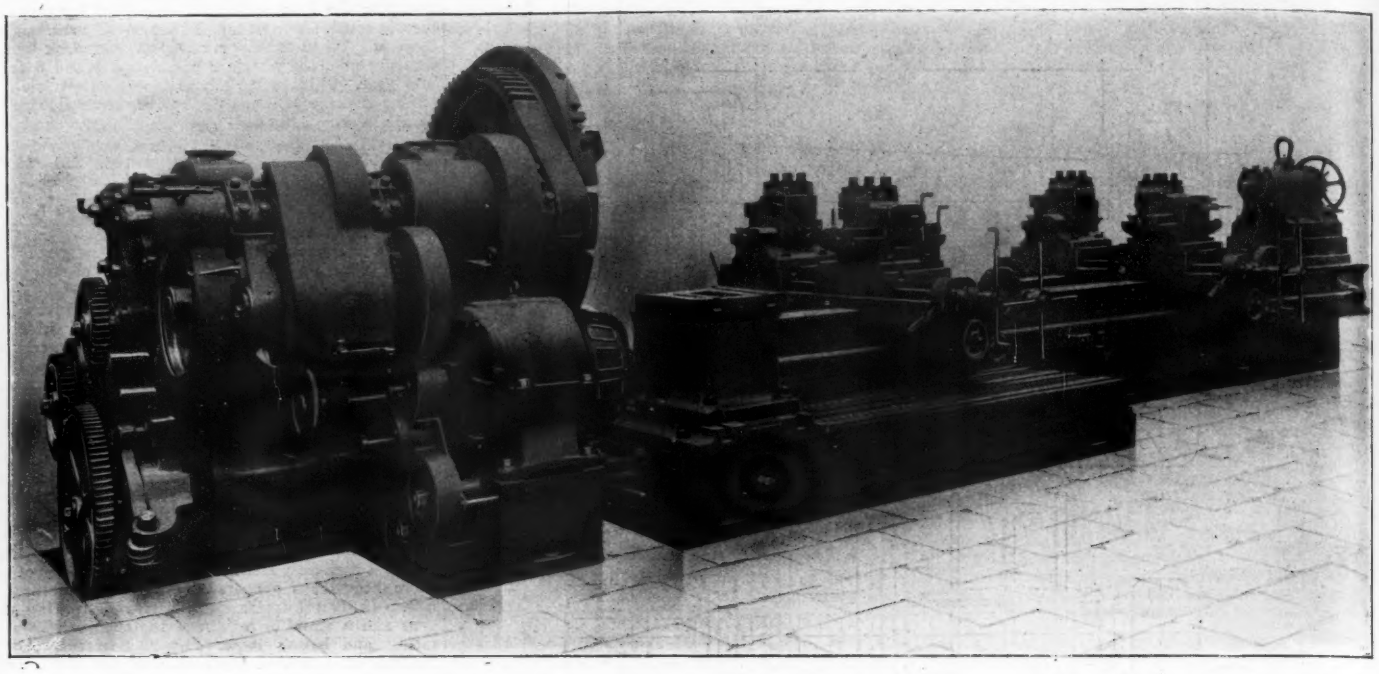


Fig. 51—30-INCH MOTOR DRIVEN LATHE—CRAVEN BROTHERS, LIMITED

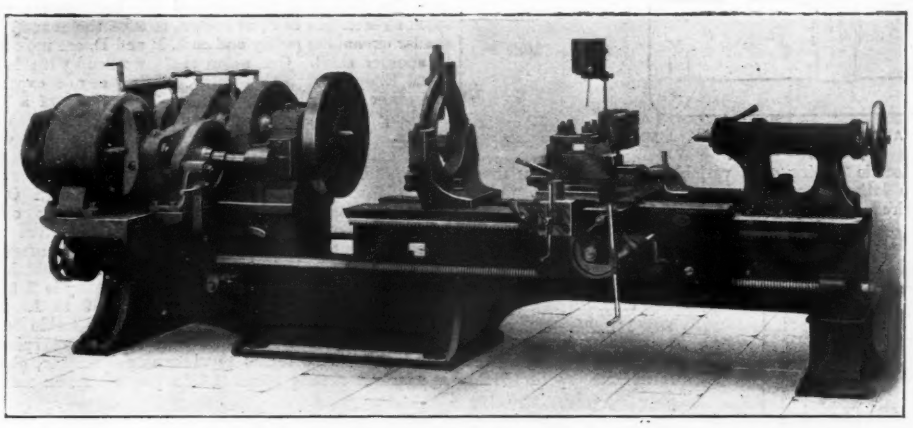


Fig. 52—12½-INCH MOTOR DRIVEN LATHE—CRAVEN BROTHERS, LIMITED

These headstocks, which look rather large until one remembers that no countershaft cone is used with them, appear to work excellently, and are particularly economical on facing work, when the cross feed is connected with the change-speed gear, so that approximately the correct cutting speed is maintained automatically. The belt is made by screwing a number of battens of wood to Balata belting. The ends of the battens are faced with leather. There is no difficulty about shortening the belt if ever it become necessary, but means of adjusting its tension are provided in the gearing.

But besides this variable speed lathe, Messrs. John Lang and Sons make a special lathe for high-speed steel. This is a gap lathe of 16in. centres, driven by a four-step cone pulley of very large diameter, mounted on a separate shaft and geared to the main spindle. The spindle speeds when the countershaft runs at 155 revolutions per minute are 36·4, 28·9, 23, 18·3 11·6, 9·2, 7·3, and 5·8. The steps take a 5in. belt; the largest is 36in., the smallest 25½in. diameter, and the ratio is 6 to 1 in single and 18 to 1 in treble gear. The front bearing of the main spindle is 9in. diameter. The bed is 28in. wide across the face, and only the front shear is used for guiding purposes, so that cross winding is reduced to a minimum. The loose headstock is guided by the inner edge of the back shear and a special inclined guide a short distance inside the front shear. It is of a powerful design, held down by three bolts, two short and one long. The spindle is of the solid type, screwed for nearly half its length, ground all over, and fitting into the whole length of the barrel. It thus is very well guided and supported. There is a good arrangement to allow for its sideways movement for taper work.

We might mention that arrangements are made for cutting coarse pitch screws or worms. The cone is on a side shaft, which is geared to the main spindle in the ratio of 1 to 6. This cone shaft may be coupled to the lead screw by change wheels, and thus when equal gear is used on the cone shaft and screw a leading screw of ½in. pitch will cut a worm of 3in. pitch. We may say also that in recent designs a brake has been applied to the large pulley, which naturally, with its great diameter and speed, acts as a fly-wheel. It will be noticed that the faces of the bed of the face plate lathe are protected in a very neat way by cast iron covers. These are bolted to the bed and pass freely through passages cast for that purpose in the base of the saddle.

Craven Brothers, Limited, of Manchester, have also turned their attention to the design of special high-speed lathes, and we have selected a couple of sizes for illustration. That shown in Fig. 52, is a 12½in. centre sliding, surfacing, and screw-cutting gap lathe. It has four changes of speed through gearing by positive clutches, and is driven by a 15 brake horse-power variable speed motor, having a speed variation of 2 to 1, and giving spindle speeds of from 4 to 48 revolutions per minute. The feeds are instantly changed by handle on the front of the bed. The direction of feed can also be reversed, as in most modern lathes, without stopping the lathe, by means of a handle on the front of the carriage. The feed-gearing gives self-acting traverses of $\frac{1}{6}$in., $\frac{1}{14}$in., $\frac{1}{32}$in., and $\frac{1}{56}$in. per revolution of the spindle. The device shown on the surfacing screw is for quickly withdrawing the tool to a definite distance when screw-cutting. The lathe is capable of taking a cut ½in. deep by ⅛in. traverse in mild steel, at 50ft. per minute, which without being phenomenal, may be regarded as a good, useful commercial speed for a general purpose lathe.

The larger machine, Fig 51, by the same makers is a 30in. centre sliding, surfacing, and screw-cutting break lathe, suitable for dealing with heavy shafts, and fitted with a pillar rest for face-plate work. The headstock is treble geared, driven by a 40 brake horse power variable speed motor, and has six changes of gearing through sliding pinions, giving all intermediate speeds from 1 to 64 revolutions per minute of the face-plate, and capable of taking two cuts, each ⅜in. deep by ⅛in. traverse, or the equivalent in sectional area, at 60ft. per minute. The sliding feeds are effected through change wheels on a swing frame at the end of the headstock, moving the carriage by means of a 5in. diameter screw, and giving traverses from $\frac{1}{80}$in. for fine boring up to 6in. for screw cutting, per revolution of the face-plate. All gearing is, it is needless to add, machine cut. The quick adjustment is actuated by a pinion gearing into the screw, and can be effected either by power or by hand; the top bed can also be quickly moved for opening or closing the break by power. Surfacing traverses are variable through change gearing on the front of the carriage, and the carriages are so arranged that one can be sliding and the other surfacing at the same time. The change wheels on the front of the carriages may also be used in conjunction with the sliding motion for taper turning.

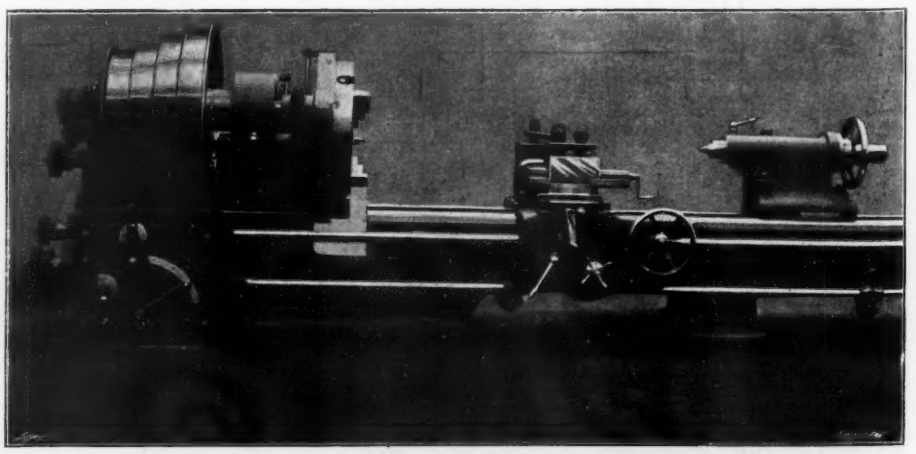


Fig. 53—16-INCH HIGH-SPEED LATHE—JOHN LANG AND SON

THE ECONOMICS OF ELECTRIC TRAMWAYS IN BRITAIN.

By Robert H. Smith.

In Table I. are given figures deduced from the published statistics and accounts of a number of British tramway systems. They are taken in most cases from the reports issued this year, but in some few, where these are not yet available, from last year's reports.

The first line gives average results over about 1000 miles of such tramways taking large and small, favourably and not favourably situated, together; but excluding such as have evidently no chance of success. The following lines cite examples that are fairly typical of large and small installations in districts of very various character.

In the columns 12 to 15 are given figures reduced to per car-mile run. This is the reduction most commonly made, and these figures can be obtained directly from the annual reports. Those in the other sixteen columns of the table have to be calculated from the statistics given in the reports.

Table I.—*Economic Results on some Typical Large and Small Overhead British Tramway Systems.*

Locality.	Miles of single track.	Ratio of single-track mileage to route mileage.	Population served per mile single track.	Capital outlay per mile single track.	Number of cars per mile single track.	Annual passengers per mile single track.	Annual car mileage per mile single track.	Average time interval between cars.	Annual traffic revenue per mile single track.	Annual passengers per car.	Annual car mileage per car.	Annual traffic revenue per car.	Passengers per car-mile.	Traffic revenue per car-mile.	Working costs per car-mile.	Energy consumption per car-mile. Board of Trade units.	Ratio of annual revenue to capital outlay.	Ratio of working costs to revenue.	Ratio of annual working costs to capital outlay.	Ratio of annual excess of revenue over working costs to capital outlay.	Ratio of net profit to capital after deducting 5 per cent. depreciation, sinking fund, and interest.
			Unit 1000.	Unit £1000.		Unit 100,000	Unit 1000.	Min.	Unit £1000.	Unit 100,000.	Unit 1000.	Unit £1000.		d.	d.	B.T.U.	Percent.	Percent.	Percent.	Percent.	Percent.
			1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
Average of 1000 miles in various place	—	1·6	6·1	14·5	3·2	6	73	4·8	3·2	1·9	23	1	10	10·5	6·2	1·28	22	60	13·2	8·8	0·8
Glasgow	135	1·9	6·5	19	5·0	14	116	3	5·13	2·8	23	1·03	11·5	10·6	5·2	·94	26·5	50	13·2	13·3	5·3
Croydon	17	1·6	7·7	13·9	3·5	7·6	89	4	3·55	2·2	25	1·00	8·5	9·5	5·4	·87	25·5	57	14·5	11·0	3·0
Liverpool	103	1·6	7·2	18	4·8	11	114	3·1	5·15	2·3	21	1·08	9·5	10·7	7·0	1·53	28·5	61	18·2	10·3	2·3
Leeds	82	1·8	5·2	13	3·0	7·4	74	4·7	3·4	2·5	25	1·1	10·0	11·0	6·6	1·3	26·2	61	16·0	10·2	2·2
Nottingham	30	1·9	8·0	19	3·5	9·3	84	4·2	4·28	2·65	24	1·22	11·1	12·2	6·8	1·37	22·5	56·6	12·6	9·9	1·9
Hull	25	1·85	5·8	15·3	4·7	9·7	100	3·5	4·04	2·1	22	·87	9·6	9·6	6·1	1·26	26·4	63·2	16·6	9·8	1·8
Aberdeen...	21	1·7	7·5	12·4	3·3	5·8	46	7·6	2·4	1·76	14	·73	12·6	12·5	6·8	1·05	19·4	54	10·6	8·8	0·8
Ayr	8	1·3	1·2	9·3	2·0	4·0	42	8·3	1·7	2·0	21	·85	9·5	9·8	5·1	1·00	18·3	52	9·5	8·8	0·8
Southampton	17	1·7	6·2	11·7	2·9	5·8	67	5·5	3·05	2·0	23	1·06	8·6	10·9	7·7	1·13	26·1	70·7	18·5	7·6	—
Huddersfield	35	1·25	3·4	11·8	2·0	3·4	47	7·5	1·82	1·7	23	·91	7·3	9·3	5·0	1·57	15·5	54·1	8·4	7·1	—
Dublin United and S. District...	47	1·9	3·9	19·2	3·2	5·4	76	4·9	2·77	1·7	21	·87	7·1	8·6	5·4	1·06	14·5	55	8·0	6·5	—
Newcastle-on-Tyne ...	45	1·96	5·2	23·4	3·7	8·8	90	3·9	4·01	2·4	24	1·08	9·8	10·7	7·2	1·91	17·1	67·3	11·5	5·6	—
Halifax	44	1·3	5·0	7·7	2·0	3·6	30	11·7	1·49	1·8	15	·75	12·0	12·0	9·05	1·80	19·5	75	14·7	4·8	—

Although results per car-mile are important and instructive, they by no means exhaust the useful analysis of the working. So far is this from being so, that it is very surprising that in reports and discussions on tramway work attention should be so uniformly, and almost exclusively, concentrated on this one aspect of the matter. Evidence of this too exclusive view, and of the eager competition between managers based solely on this view, is afforded by the closeness together of the figures in column 13, where the revenue per car-mile is 10·6d., 10·7d., 11·0d. and 10·7d. in four of the most important places, and 12·2d., 12·0d. and 12·5 in three other fairly comparable places. But if one compares this closeness in column 13 with the widely divergent final results given in column 20, one cannot help seeing that exclusive consideration of results per car-mile cannot be very instructive, and may be extremely delusive.

To obtain a reasonably complete insight into the reasons of success, or the reverse, of a tramway system, there are at least five different aspects of the working that must be examined. The results must be viewed in relation:—(1) To the length of line; (2) to the quantity and quality of the population served; (3) to the number of cars employed; (4) to the capital expended; and (5) to the car-mileage per unit of time. The different sections of the table here given enable one to examine these five aspects of the problem.

In order to put aside at once one elementary matter—not usually explained, but capable of exact and simple arithmetic statement—let us see what the necessary car-mileage depends upon.

Other conditions, such as the distance headway between cars, being the same, evidently the number of cars out at one time on any system of roads is proportional to the length of these roads. Thus it is rational to consider the question from the point of view of car-mileage per mile of single track.

In any large unit of time the number of cars run over each mile of single track is clearly inversely proportional to the average time interval between successive cars passing the same place, and therefore the car-mileage per mile of single track is solely in inverse proportion to this time interval. It does not in any direct way depend upon the average car speed. The average space interval between successive cars, for a given time interval, is proportional to the speed, but then also for such specified time interval the number of cars at one time per mile of road is inversely proportional to the speed. Thus the influence of speed may be cancelled out, and the total car-mileage in a large time unit is solely proportional to the ratio of the miles of single track to the average time interval between cars.

Thus, if there were a one-minute service maintained steadily throughout 16 hours per day on 365 days per year, then $60 \times 16 \times 365 = 350{,}400$ cars would run over the whole system per year, and 350,400 car-miles per mile of track would be the result, whatever the average speed, and whatever the extent of line. If T be the average time interval maintained through 16 hours each day in the year, L the length of single track in miles, M the yearly car-mileage, then $M = 350{,}400 \frac{L}{T}$. In some places the cars run more than 16 hours per day, but, as this is about the average throughout the country it is convenient, for the purposes of comparison, to throw the cars run beyond the normal 16 hours into the 16 hours, lessening correspondingly the average time interval below the actual interval. Beyond the 16 hours, and sometimes beyond 12 or 14 hours, the time spacing of the cars is made three or ten times longer than within the normal hours. Thus the reduction to a standard of 16 hours does not much change the average from the actual time interval.

The annual mileage M per year being known from the official records, as also the length of track L, the calculation of the time interval reduced to standard 16 daily hours all the year round is

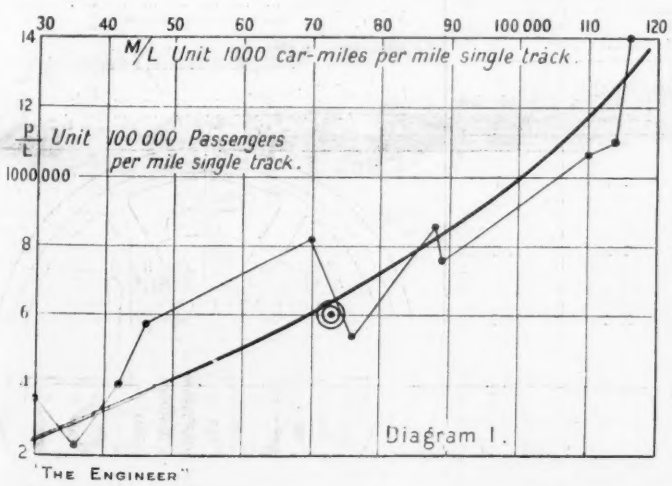
$$T = 350{,}400 \frac{L}{M};$$

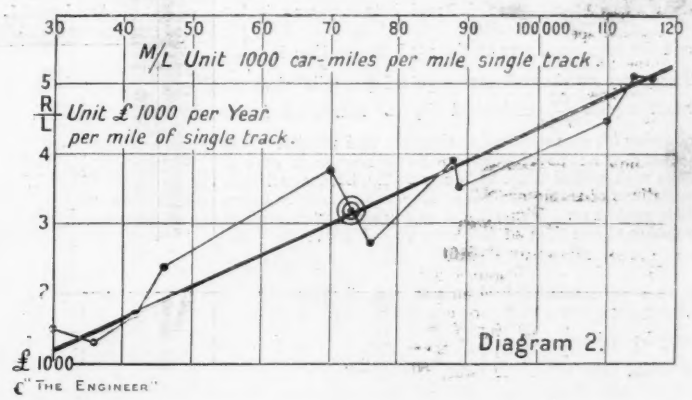
that is, divide, say, 350,000 by the yearly car-mileage per mile of single track. Thus, a 3½-minutes service corresponds with 100,000 car-miles per mile single track. This is the way in which column 7 of the table is calculated. It is calculated because the time interval is a very easily understood—inverse—measure of the density of the traffic, and it is reduced to the above standard in order to make the results in different places fairly comparable.

When it is understood that column 6, "Annual car-mileage per mile single track," is nothing else except the reciprocal of the mean time interval multiplied by a proper constant numerical factor, it is seen at once that column 6 is the true and only proper measure of the vigour with which the line is worked—considered apart from the degree to which it is used by the public, that is, whether the cars be full or empty. It is, in fact, the number of times per year that each part of the track is utilised by passing a car over it.

If the cars were always full to the same percentage of their carrying capacity, the car-mileage per mile single track would also be a correct measure of the use made of the tramways by the public. The annual passenger mileage per mile single track would measure this use accurately. The passenger mileage is never ascertained directly; it would be a practical impossibility to do so. The yearly passengers are counted by the tickets sold; and this number reduced to per mile of single track is the best measure of the travelling activity of the public that can be directly calculated from published statistics. This is given in column 5 of the table.

Column 6 gives a true measure of the facilities afforded to the public; column 5 gives the nearest directly ascertainable measure of the use made of these facilities. It is easy to feel sure that, within certain limits, the use


30 40 50 60 70 80 90 100 000 110 120
M/L Unit 1000 car-miles per mile single track.
P/L Unit 100 000 Passengers per mile single track.
14 12 1000 000 8 6 4 2
Diagram 1.
"The Engineer"


30 40 50 60 70 80 90 100 000 110 120
M/L Unit 1000 car-miles per mile single track.
R/L Unit £1000 per Year per mile of single track.
5 4 3 2 £1000
Diagram 2.
"The Engineer"

made of them will increase with the facilities offered. But diagram 1 reveals what would not be easily anticipated, namely, that up to the limits yet attempted in Britain the use made rises in an increasingly rapid ratio with abundance of facilities. The horizontal ordinate measures this abundance of facility by M/L, while the verticals to the points and to the mean curve measures the use made of them by P/L, or the figure in column 5. The points apply to particular localities, and as there are great local variations of condition, these points deviate apparently erratically from the mean curve; but they indicate without any doubt the general character of the mean curve. The large dot surrounded by two circles gives the mean of 1000 miles in various typical localities. The ratio between the ordinates to each dot is the passengers per car-mile—a ratio usually calculated and published in the annual report, and which is given in column 12 of the table.

Independent of public utility, but most important in respect of the financial success of the tramway considered as a paying business, is the traffic revenue reaped from passengers. All the statistics show that the great bulk of this revenue is reaped in one-penny fares. The proportion obtained from halfpenny fares is never more than one-sixth, and that from fares greater than the penny is so small as to suggest the policy of abolishing all such fares, and of giving the whole journey from centre to periphery or *vice versâ*, for one penny, a policy which would save in costs in many ways. In some cases, however, the mean fare is over 1¼d. If it were one penny, then each 100,000 in column 5 would yield $\frac{100{,}000}{240 \times 1000} = £0{\cdot}417$ in column 8, in which is stated the actual revenue from fares per year and per mile of single track. This column shows that the actual revenue per mile of track ranges from as little as £1300 up to £5150. In diagram 2 is shown how this revenue increases with the service as measured by M/L, the car-mileage per mile of track. In this diagram the mean results are well represented by a straight line, which is drawn across it in thick full line. Its equation is—

£ Revenue per Year per Mile Single Track
= ·045 Car-mileage per Year per Mile S. Tr. − £150;

an equation which would mean that about 3500 car-miles per year per mile of single track is the least that would just begin to draw any passenger revenue.

The curved line of diagram 1 also runs down to $\frac{P}{L} = 0$ at M/L between 3000 and 4000. Both these diagrams show very clearly the importance of developing to the fullest possible extent the car-mileage per mile of track. This importance is due to 50 per cent. of the capital expenditure being in proportion to the length of track, and to the advantage, universal in all industries, of a quick turnover of capital outlay.

Another considerable proportion, namely, 15 per cent., of capital expenditure is upon rolling stock. The annual car-mileage run per car employed is, of course, the direct measure of the activity of this part of the capital outlay. The rate at which the public uses it is measured by the yearly passengers carried per car; and the earning capacity is the annual traffic revenue per car. These three interesting quantities are tabulated in columns 9, 10, and 11. The annual earnings per car on successful tramways does not vary greatly from £1000; but in some cases as much as this is earned without the total result being fortunate. The car-mileage run per car in one year is singularly constant at all places, ranging only from 21,000 to 25,000, except in a few very special cases.

23,040 miles at a mean speed of 8 miles per hour take 2880 hours to run over, or 180 days of 16 hours each. This seems to be nearly the maximum duty per car, the rest of its time, or 365 − 180 = 185 days, or half the year, being spent in cleaning, repairs, and waiting, as reserve for special heavy traffic days. The number of cars required depends on the length of the line and upon the average speed, according to the following relation. If the speed be V miles per hour $= \frac{V}{60}$ miles per minute, and the service be for a mean time interval of T minutes, then the mean space interval between cars is $\frac{V\,T}{60}$ and the number of cars on the road at one time is $\frac{60\ L}{V\,T}$. Thus, the number of cars required per mile of single track equals $\frac{60}{V\,T}$ multiplied by a numerical factor allowing for cars stabled for cleaning and repairs. This factor does not cover an allowance for reserve of cars to cope with special times of heavy traffic, because all such variations of traffic are taken into the annual averages here spoken of. Thus, if the yearly average percentage running at one time of the cars owned be 75, then the number of cars required is $\frac{80}{V\,T}$ per mile of single track.

If T be expressed in terms of car-miles per mile as above, then the number of cars on the road at one time may be written $\frac{60\,M}{350{,}000\,V} = \text{say}, \frac{M}{5800\,V}$. Taking V at a mean of 8 miles per hour, and allowing a mean of 50 per cent. of the cars being on the road at one time, this gives the total number of cars equal to $\frac{M}{23{,}000}$, and this agrees with the figures given in column 10 of the table. Either of these expressions exhibits clearly the commercial advantages of high speed. The capital invested in rolling stock is inversely as the speed; the streets are kept clearer in direct proportion to the speed, the space interval between the cars being so; and the inducement to travel offered to the public is very greatly increased. These advantages are so important that quite certainly the speed would be greatly raised above the existing limits if risk of accident to pedestrians and other vehicles did not severely restrict such extension.

Except for this consideration of the profitableness of high speed, the table shows it to be very poor policy to scrimp the line in respect of number of cars per mile of track. The number of cars per mile, and the ratio of single track length to route length, are among the clearest indications of the fertility of each district in tramway business.

A large part of the capital expenditure depends on, and increases proportionately, to the length of track. Another part, including cars and car sheds, depends in the same way upon the number of cars. Another depends on the car-mileage per year, which is virtually a time rate of working, and to which, therefore, for a given load factor, the kilowatt power of the central station must be proportioned. If an initial constant be added to these three parts, and the whole be reduced to per mile of single track, there is obtained a formula of the character

$$\frac{£30{,}000}{L} + £6000 + £1000\,\frac{C}{L} + £0{\cdot}04\,\frac{M}{L},$$

where L is the single track length, C the number of cars, and M the annual car-mileage. But all the four numerical factors vary with local conditions by over 20 per cent. up or down from those here stated; the first of them varying much more than this. If the average annual car-mileage per car, 23,000, from the table be used—a figure which varies very little, as proved by the table—the third and fourth term of this formula may be combined into one; thus

$$\text{Capital outlay per mile single track} = \frac{£30{,}000 \text{ to } £100{,}000}{L} + £6000 + £0{\cdot}08\,\frac{M}{L}.$$

The working costs may be analysed in precisely the same manner into four parts corresponding to the above, and these may be similarly reduced to three parts. The easiest method of calculating these costs is to take from the table the average ratio to the traffic revenue, namely, 60 per cent., which, according to the factors obtained from Diagram 2, would make them equal

$$£0{\cdot}027\,\frac{M}{L} - £90$$

per mile of single track. This, however, is not rational, and a much nearer approximation to the actual tabulated figures is obtained by the formula:

$$£0{\cdot}02\,\frac{M}{L} + £200 \text{ to } £150,$$

or, reducing to the more commonly used money unit, say,

$$\text{Pence } \left\{4{\cdot}8\,\frac{M}{L} + 40{,}000\right\}$$

To illustrate, now, the resultant effect of these economic tramway laws, we find on a rough average

$$\text{Net revenue per mile single track} = \text{Traffic revenue} - \text{working costs} =$$

$$£\left(·045 - ·02\right)\frac{M}{L} - £150 - £150 =$$

$$£\left\{·025\,\frac{M}{L} - 300\right\};$$

and the ratio of this to capital cost is

$$\frac{\text{Net revenue}}{\text{Capital outlay}} = \frac{·025\,\frac{M}{L} - 300}{·08\,\frac{M}{L} + 6000 + \frac{50000}{L}}$$

The constants inserted here are subject to considerable variation. They are used here chiefly to illustrate the influences exerted upon this economic result by the two factors L or the size of the whole installation, and $\frac{M}{L}$ the activity with which it is worked. To complete this illustration, we conclude with the following table, giving the value of this fraction, as calculated from the formula, for the four activities 25, 50, 75, and 100 thousand car miles per mile single track, and the two lengths of tramway 50 and 100 miles of single track.

TABLE II.

Ratio of Net Revenue to Capital Outlay.

$\frac{M}{L}$ Unit 1000	Any Length L.	L = 50 miles. Per cent.	L = 100 miles. Per cent.
25	$\frac{·325}{8 + \frac{50}{L}}$	3·6	3·8
50	$\frac{·95}{10 + \frac{50}{L}}$	8·6	9·0
75	$\frac{1·575}{12 + \frac{50}{L}}$	12·1	12·6
100	$\frac{2·2}{14 + \frac{50}{L}}$	14·7	15·2

Comparing these with the figures in column 19 of Table I., it is seen that this formula, with the constants inserted above, makes the value increase rather too rapidly with the car mileage. It gives a slightly too small percentage for very small mileages and a slightly too large percentage for very large mileages.

The main point to note, however, is that the effect of increasing $\frac{M}{L}$ in improving the financial result is very great, while that of increasing L is very small. This means that, with skilful and vigorous management, a system of small mileage may be made almost as prosperous as one of large mileage. But a locality that will not stand the expense of at least 50,000 car-miles per mile of single track will with difficulty yield any net profit above the 8 per cent. needed for interest, depreciation, and sinking fund.

THE INTERNATIONAL EXHIBITION AT ST. LOUIS.

(*By our Special Commissioner.*)

XXII.*—STEAM ENGINES.

THE Harrisburg Machine Company, of Harrisburg, exhibits a tandem compound horizontal engine, of 600 horse-power, which is directly connected to a generator of 400 kilowatts. This engine is of the "Fleming" type, in which Corliss valves are used, but are operated by a special valve motion which requires no trip or releasing gear, but yet gives a very sharp cut-off. It is true, however, that three excentrics and an increased number of parts are required. The engine is intended to work with 150 lb. steam pressure and 26in. of vacuum; it has a receiver of the reheating type, with horizontal tubes, to which steam is admitted at 150 lb. The principal dimensions are as follows, and it will be seen that the cylinder ratio is very unusual:—

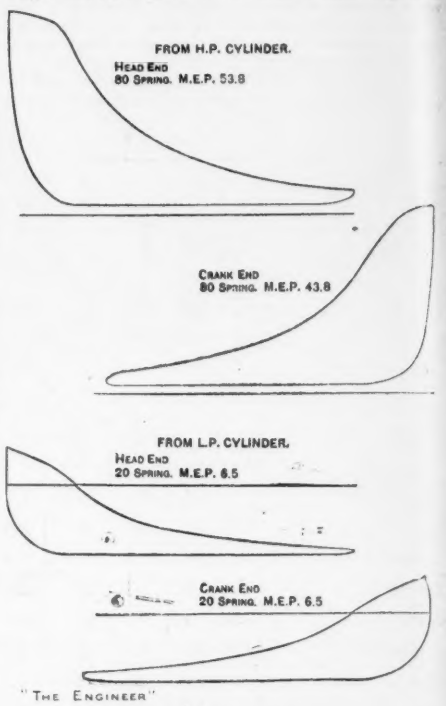


FIG 6.—INDICATOR DIAGRAMS

Cylinders, diameter	15in. and 40½in.
,, stroke	26in.
,, ratio	1 to 7·3
Cut-off in high-pressure cylinder	about $\frac{3}{10}$
Fly-wheel, diameter	10ft.
,, weight	11 tons
Connecting-rod, length between centres	5ft. 9in.
Piston-rod, high-pressure cylinder	2½in.
Piston-rod, low-pressure cylinder, head end	2⅛in.
Piston-rod, low-pressure cylinder, crank end	4⅜in.
Clearance, high-pressure cylinder	3·95 per cent.
,, low-pressure cylinder	4·67 ,,
Normal speed	150 revs.
Variation under extreme change of load	1½ per cent.
Valves of high-pressure cylinder, steam, diameter	4⅜in.
Valves of high-pressure cylinder, exhaust, diameter	5in.
Valves of low-pressure cylinder, steam and exhaust	8in.
High-pressure steam valves are triple-ported, operating in chilled cast iron bushings.	
Steam pipes, diameter	8in.
Exhaust pipes, diameter	14in.

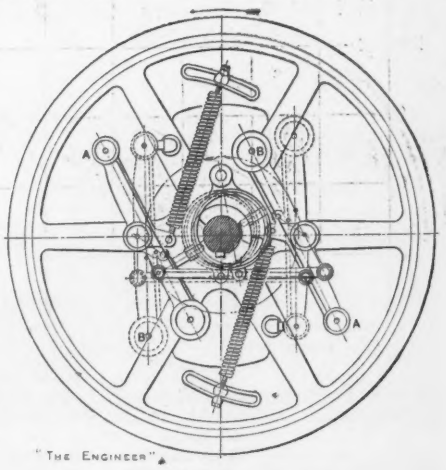


FIG. 7—SHAFT GOVERNOR

The design is both new and interesting, and was the source of considerable discussion when the design was described in a paper read at a meeting of the American Society of Mechanical Engineers a few months ago. The general arrangement is shown in Fig. 8, while Fig. 9 is a

* No. XXI. appeared October 28th.

SIX-HUNDRED HORSE-POWER TANDEM COMPOUND HORIZONTAL ENGINE

THE HARRISBURG MACHINE COMPANY, HARRISBURG, U.S.A., ENGINEERS

(*For description see page* 462)

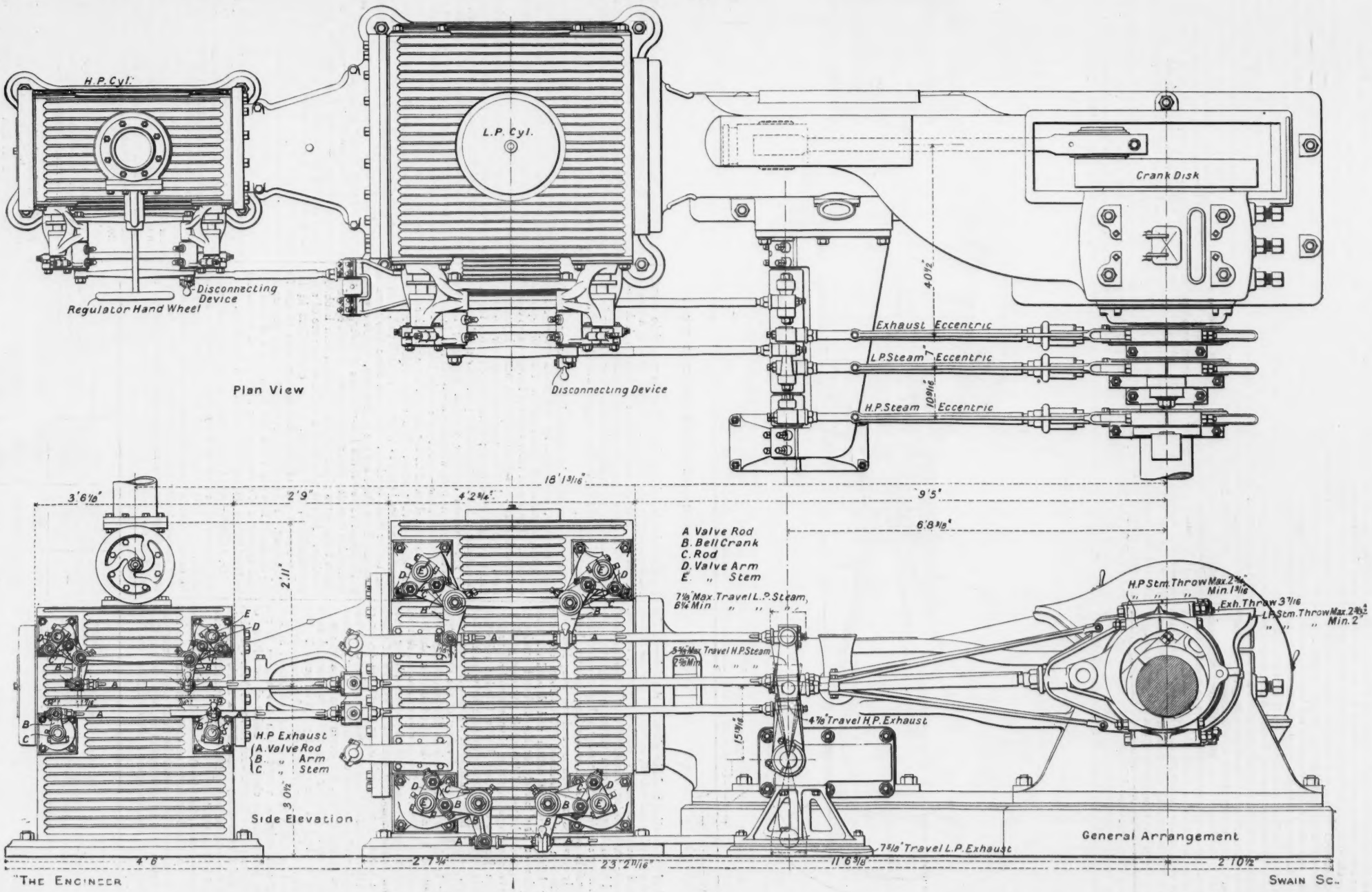


FIG. 8

section through the cylinders and valves, and Fig. 6 shows some of the indicator diagrams. In respect of novelty of design and departure from ordinary practice, this is one of the most notable engines at the Exhibition.

As explained by Mr. B. T. Allen, the builder of the engine, at the meeting above referred to, the object in view in the design was to combine the advantages of the most economical slow-speed Corliss engines with the desirable features of compactness, higher speed, closer regulation, and more efficient methods of lubrication, all of which are features of the high-speed "automatic" engine. In order to realise the economy of steam consumption of the best Corliss engine practice, it was at first considered essential to use the vacuum dashpots and other accelerating devices common to Corliss engines to give the sharp cut-off and more perfect steam distribution.

"It was found that with an improved form of detachable cut-off, such engines could be made to operate fairly satisfactorily at speeds considerably in excess of that generally used on the Corliss engine; but yet the resultant speed was not as great as was desired for some purposes, especially electrical, and the design of the valve gearing still possessed many disadvantageous features. After exhaustive investigations it was finally found by substituting for the detachable form of cut-off, a peculiar arrangement of bell cranks and levers, that a satisfactory amount of acceleration could be given to the valves at the points of admission and cut-off, and this by angular motion only, and unencumbered by elaborate cut-off devices. This accelerated motion, combined with the advantage obtained by making the steam valves triple-ported, produced a more satisfactory operation at higher speeds than was possible with the other devices, besides being absolutely noiseless in operation and requiring less care and attention for maintenance. This form of valve gearing being positive in action and dependent upon a variation of the travel for the different grades of expansion, made the use of the shaft governor possible, with all its accruing advantages of speeds and regulation. No steam jackets are used, but a tubular reheating receiver is placed in the steam passage between the two cylinders, steam being admitted to the high-pressure cylinder through triple-ported valves of the Corliss type working in chilled iron bushings, the governing being accomplished by a centrally-balanced inertia shaft or wheel governor—Fig. 7. This governor is so constructed that it is practically balanced in all positions, being made with two inertia arms, the centres of gravity of which move in harmony with each other about the centre of rotation, the balancing feature avoiding surging or violent action under all conditions of operation. This operates, by means of bell cranks, the steam admission valves of the high-pressure cylinder only, and is so arranged as to decrease the lead at the earliest point of cut-off. The steam valves of the low-pressure cylinder are controlled by a fixed excentric, so arranged that the cut-off in that cylinder can only be varied when the engine is not running, and remains constant, under all conditions of load and pressure. The exhaust valves of both cylinders are of the Corliss type, operated by a single excentric through the medium of a peculiar arrangement of rocker arms and bell cranks."

As already noted, the steam valves of the high-pressure cylinders operate in removable cast iron bushings, and the ports are so arranged that the three edges are opened at one time. This arrangement of triple ports, combined with the rapid angular motion obtained from the bell-crank connections, gives a very quick admission and cut-off. It will be seen from Fig. 8 that the valve rods are attached to the legs of bell-crank levers, the other leg of each bell crank being connected by a short rod or link to the crank arm keyed upon the valve stem. The arrangement may be compared with that of the Westinghouse-Corliss engine, shown in Fig. 34, page 223 of THE ENGINEER for September 2nd. The valve bushings can be renewed when required, thus obviating the necessity of boring out the holes. The steam valves of the low-pressure cylinder are also triple-ported, but have a different arrangement of steam passages and do not work in bushings. The exhaust valves in both cylinders are single-ported, being virtually plug cocks which close in such a manner as to entirely eliminate the space inside the valve from the clearance volume.

The governor, Fig. 7—already referred to—has two weights on opposite sides of the centre to preserve the gravity balance. When the wheel is running in the direction shown by the arrow any sudden acceleration causes the weights A A to lag, with reference to the motion of the run, by reason of their inertia, carrying them to the position shown in dotted lines. The movement toward that position is furthered by the centrifugal force due to the increased speed acting upon the larger weights B B. Any movement towards that position, however, carries the excentric towards the centre, reducing the valve travel and shortening the cut-off to correct the tendency to acceleration. Should there be a retardation of the wheel, the momentum of weights A A would carry them away from the dotted position, assisting the springs in drawing in the weights B B, and increasing the radius of excentricity. The weights are all carried upon roller bearings.

The valve motion is operated from three excentrics. One excentric, controlled by the shaft governor above described, operates the steam valves of the high-pressure cylinder. The steam valves of the low-pressure cylinder are operated by the second excentric, which is practically fixed to the shaft, but has a point of suspension similar to that used on the governor; by means of a screw it can be moved across the shaft, and the point of cut-off varied in the low-pressure cylinder without changing the lead. This can be done only when the engine is not in motion. The third excentric—next to the main bearing—controls the exhaust valves of both cylinders by a combination of cast steel rocker arms. The arms which operate the steam valves are keyed to the shaft at each end, next to the rocker shaft bearings. Between these two arms at the ends of the shaft are the rocker arm, which connects to the steam valves of the low-pressure cylinder, and the arm which operates the exhaust valves of both cylinders. These latter arms ride loose on the shaft, with babbitted bearings. All the pins in the valve motion are of steel, case-hardened, and ground. The connections in the valve motion are of phosphor bronze, with means for adjustment. For each pair of valves there is a disconnecting device to free the valve rod from the bell crank, so that by means of a starting bar each pair of valves can be tried before the engine is turned over by steam.

Mr. Allen favours a short stroke as tending to economy, and states that in tests of a number of Fleming engines he has found that in every case the economy was found to exceed that of the Corliss engine, either medium or long stroke, under similar conditions. The results of some tests of the tandem-compound Fleming engine are as follows:—

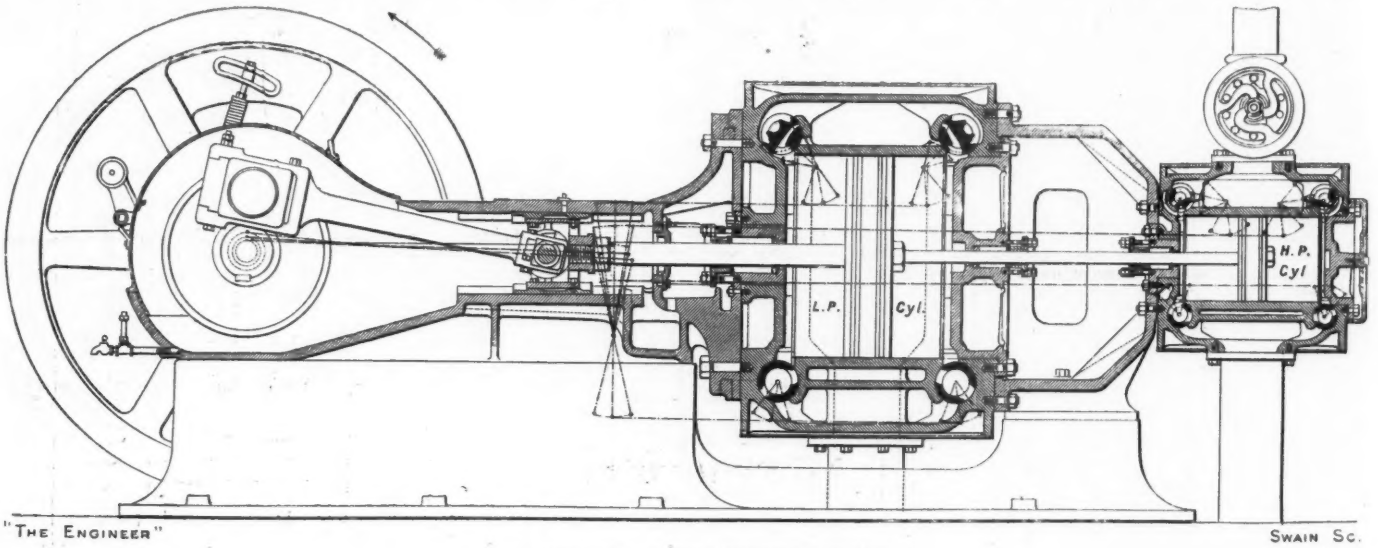


Fig. 9—HARRISBURG TANDEM COMPOUND ENGINE

Load.	Duration in hours.	Revolutions per minute.	Gauge pressure, pounds at throttle.	Vacuum by gauge, in.	Horse-power, high-pressure cylinder.	Horse-power, low-pressure cylinder.	Horse-power, total.	Steam used per I.H.P. per hour, including quantity used in reheater.
About $\frac{1}{4}$ load	2	155·18	89·72	26·5	44·34	42·73	87·07	14·12
About $\frac{3}{8}$ load	3	151·25	129·9	26·0	167·73	153·81	321·54	13·59
About $\frac{7}{16}$ load	2	152·33	149·4	26·0	176·19	172·09	348·28	12·33
About full-rated load ...	5	150·09	152·0	25·9	249·96	251·59	501·55	12·66
About $1\frac{1}{16}$ load	2	148·89	153·0	25·5	267·24	286·25	553·49	12·73

THE IRON AND STEEL INSTITUTE IN AMERICA.

LAST week we gave a brief account of the meeting of the Iron and Steel Institute in New York. Our report dealt with the proceedings up till the morning of Wednesday, 26th October.

The only paper read in the afternoon was that by Mr. Gledhill, entitled "The Development and Use of High-speed Steel"—see page 482. A number of specimens had been prepared, and were exhibited in the meeting room. They were the same as those employed to illustrate the lecture given by Mr. Gledhill some months ago at Coventry, and published in our issue of March 11th last. Possibly the most significant fact brought out by them was that it is now quite possible to obtain a high finish by the use of high-speed steel, it only being necessary to use a sufficiently fine feed, in several of the examples shown the traverse being as little as $\frac{1}{32}$in. per revolution. The machines employed for this work were Herbert capstan lathes, and, even with this fine feed the speed of cut was kept so high that a very remarkable economy was realised.

The discussion was opened by Professor Howe. The author of the paper says that he has "proved conclusively that the most satisfactory results are obtained only by using the purest qualities of Swedish or Dannemora irons." This statement Professor Howe was unwilling to accept. He asked if it had been really shown that Swedish iron was better for their purpose than other equally pure iron, and if it was absolutely beyond question that a cemented steel must be used, and that the product of the open hearth is unsuitable for the manufacture of tungsten steels. Commenting on the analysis of high-speed steel, he expressed a hope that it might be found possible to use for its composition the ordinary rather than the rare elements, of which the quantity appeared to be limited, and which might, in not many years' time, be exhausted.

Mr. White, of the Taylor-White process, having at the invitation by the President made a few remarks on the development of this kind of tool steel, Mr. Tom Westgarth continued the discussion. He said that there could be no doubt that much benefit had been derived from high-speed steel, and he wished to record the obligations which they were under to the American engineers who had started its development. Whilst, however, he agreed that great advantages were obtained from its employment, he did not think it quite fair to claim the whole credit for the tool. Concurrently with its progress, the machine had to be developed, and certainly some of the advantages obtained should be credited to it. As an example of the economy that resulted from the use of higher cutting speeds, he mentioned that in getting out the plans for a new smiths' shop he had found it unnecessary to make it so large as in former cases, because the amount of smiths' work now desirable was much reduced, since it paid better to work from the bar. Referring to the speeds given on some of the samples exhibited, and particularly to two identical jobs, one of which took 3 hours 45 minutes with the old steels, and only 45 minutes with the new, he said he considered them misleading, as obviously such a great reduction was not possible in the same machine, and that the job ought certainly not to have taken the longer time recorded. He mentioned the curious fact discovered by one of his workmen, that if rough forgings or castings were painted over with chalk, it was possible to machine them at an appreciably higher speed, and in conclusion he stated that, whereas it was generally very difficult to get men to consent to a reduction of their time limits under the premium system, they would willingly agree to a 50 per cent. reduction if they were given high-speed steel, and the machines were arranged to use it at suitable speed.

Mr. G. H. Campbell, of Steelton, referred also to the question of employing Swedish steel, and mentioned that his firm did not use it in the manufacture of high-speed steels. He was supported in his view that a pure American steel might be used by Dr. Mathews, of the Crucible Steel Company of America, who also confirmed Mr. Gledhill's views as to the use of molybdenum.

Mr. Pye Smith, of S. Osborn and Co., Sheffield, noted the

admission in the paper that tungsten steels are very hard and brittle, and he pointed out the danger of stamping names or numbers deeply upon tools, as the nucleus of a crack was frequently thus formed. He asked for some information about the use of manganese, as he understood from Mr. Metcalf's book that it, in conjunction with tungsten, had a marked effect on the nature of steel. He noted that molydenum appeared to be far more used in America than in Great Britain in the composition of these steels.

Professor Richards made the same observation, and pointed out that the great advantage in the use of molybdenum lies in the fact that it gives the qualities belonging to a high carbon steel with a lower percentage of carbon, and hence less brittleness.

Mr. Oberlin Smith spoke of the great developments that were to be brought about in the design of machine tools in the next few years, particularly the planing machine. He thought that the table-planing machine would gradually be superseded by a machine of the pit type, in which the tool and not the work moves. Only in machines of this kind could we hope to get cutting speeds up to 200ft. per minute. He thought, too, that the milling machine was likely to see great developments, and would drive the planer out of use for a great deal of work.

Mr. Walter Carter, of Sir W. G. Armstrong, Whitworth and Co., Openshaw Works, in the absence of Mr. Gledhill, replied. He regretted that he was unable to give any information on metallurgical questions, which, however, would be answered in due course by the author. Replying to Mr. Westgarth's remarks, he said that it had been proved that high-speed steel could be used economically on old machines by using larger pulleys on the countershaft, and his firm had in their works planers which used to run at 20ft. per minute now cutting at 35. It was, however, desirable to use special machines, and Mr. Gledhill was one of the strongest advocates for their employment. With regard to the time taken on the specimens exhibited, he stated that the old samples showed the method of three years ago, and the time included centering. He agreed with Mr. Pye-Smith as to the danger of stamping names on steel tools, but he did not think high-speed steel was exceptionally brittle. They had tested a tool 1¼in. square on a 15½in. steel forging with a $\frac{7}{16}$in. cut and $\frac{3}{8}$in. feed, which was a very heavy load, but it had stood it safely. If high-speed steel was treated with moderate care he did not think it would break more easily than other steels. He did not agree with Mr. Oberlin Smith that planers could not be run fast enough. They had a 7ft. planer, with a Mitchell drive, cutting at 60ft. and returning at 160ft. per minute. This, with a ¼in. cut by ¼in. feed, was as much, he thought, as any tool could be expected to stand. [In the Mitchell drive we may mention there is no sliding belt; two loose belts are employed, and first one and then the other is tightened on its pulleys by the use of a jockey wheel.] For short work milling might compete with planing, but on long work the planer was undoubtedly the better tool. Many moving tool planers were used at Openshaw for armour-plate planing. They had as many as eight tool-boxes and sixteen tools in use at once, and the machines cut both ways.

After a vote of thanks had been accorded to the author of the paper, the President announced that the other papers would be taken as read, but there would be no discussion.

He then briefly proposed a vote of thanks to the members of the Reception Committee. This was seconded very happily by Mr. Brough, who mentioned particularly Mr. Dwight, Mr. Burden, Mr. Maynard—the second oldest American member of the Institute—Mr. Martin, and Mr. Wellman. He had been working with them for several weeks, and could testify to the energy and self-sacrifice they had displayed to make the visit of the Institute a success. To this Mr. Maynard replied in a few words, expressing a hope that it would not be fourteen years before this Institute again visited America.

ENGINEERING AT GUY'S HOSPITAL.

No. III.*

A NOTABLE adjunct to a modern hospital is its laundry. At Guy's Hospital the laundry becomes of double importance, since in it not only is all its own washing carried out, but also that of Charing Cross Hospital. The undertaking is of such magnitude that it keeps occupied, and sometimes very heavily occupied, no less than thirty-three women, five boys, and three men. A large majority of the work of actual washing is done by machinery, and the skill of the consulting engineer has been requisitioned in designing and installing the necessary plant, and that of the resident engineer is continually required for the efficient management of the same.

A regular system is maintained throughout the new laundry, the clothes pursuing a straight course while undergoing the various operations, and not having to be taken backwards and forwards. It will be most convenient, perhaps, if we begin at the very beginning and trace the progress of the articles as they pass through the building. The ground floor level is slightly above the level of the surrounding ground. Concrete platforms are arranged opposite two entrance doorways. The clothes are received on to these platforms as they come from the different wards in trucks. There are two entrances. Into one is taken the ordinary linen of the hospitals which forms the major portion. Into the other go what is known as the "foul" linen, which requires special washing and treatment. This is carried out in a separate compartment which may be shut off from the remainder of the wash-house by means of doors and a high partition provided with spiked iron on the top, so that when it is necessary to do so all intercourse between the two may be prevented.

* No. II. appeared October 28th.

In addition to the foregoing, the linen from the nurses' home is passed down to another sorting room through a shoot, and is kept separate from the remainder. The foul wash-house, as it is termed, contains four washers and one hydro—a machine for drying the linen after it is washed by means of centrifugal force. The washers employed were designed specially for this particular wash-house by Mr. Kirkland and the superintendent of the hospital, and have been, so we understand, so successful that they are coming into very general use throughout the country. We give a view of one of them in Fig. 1. It will be observed that they consist of a barrel carried in trunnions. The body of the barrel is of sheet brass, and is provided with a removable door for the insertion of the clothes, which when tightly secured is water-tight. The end pieces are of cast iron, the whole barrel revolving in bearings in a well-stayed underframe. The trunnions are hollow. Into one of these can be passed either cold water or steam. The water is led into the inside of the

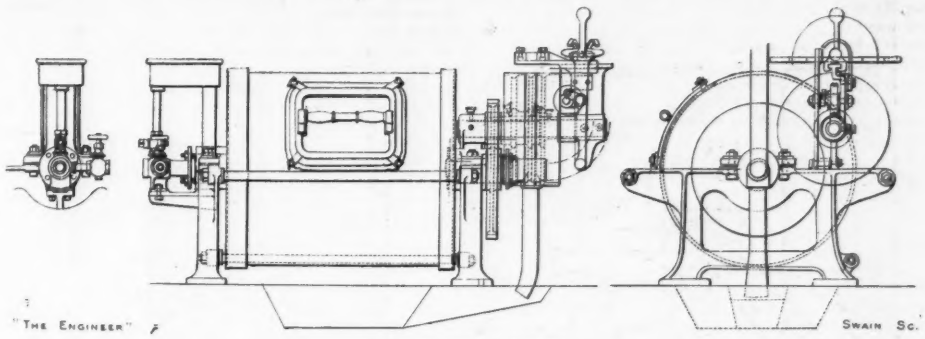


Fig. 1—WASHING MACHINE

barrel and enters channels which convey it to perforated V-shaped projections arranged lengthwise round the inside periphery of the barrel. These projections serve the purpose of turning the clothes over and over as the barrel is revolved first in one direction and then in the other, and at the same time water is being squirted out of the perforations. The level of the overflow for the water is the horizontal centre line, or, in other words, the trunnion at the other end of the barrel, so that any scum or solid matter in suspension finds an exit through this orifice. The liquid flows through a trap into a pipe running beneath the floor of the building, where it passes through another trap on its way to the sewer. It is, of course, necessary to have these traps, since the liquid is, at first at all events, nothing else but weak sewage, and sewage, moreover, which may very possibly contain disease germs. The process of washing consists in, first of all, introducing cold water and revolving the barrel to and fro. When it is judged that this has been carried on sufficiently long, steam may be turned on and the water brought to the boiling point, thereby sterilising the clothes. Then soap and soda may be put into the barrel, and, lastly, a solution of blue. The linen, when sufficiently washed, is taken out and dried in the "hydro." There are several kinds of these hydros in the laundry. That in the foul wash-house is of what is

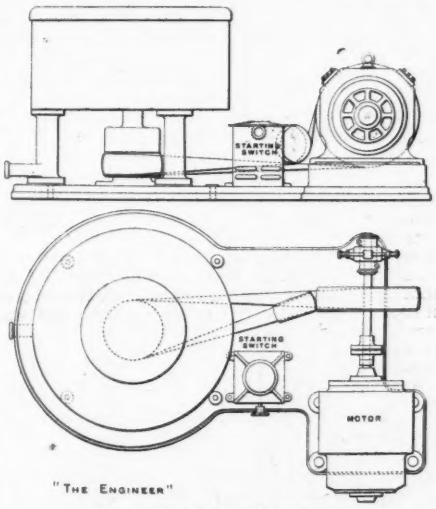


Fig. 2—UNDER-DRIVEN HYDRO

known as the under-driven type—see Fig. 2. In this the spindle is provided with a pulley below the receptacle for the linen, and there is a rubber buffer in the bearing so arranged that the spindle which is not held in a bearing at the top may freely vibrate. The hydro is driven by belt from a motor placed beside it, and we are informed that it performs its work exceedingly well. It, as were also the foul washers, was made by Messrs. D. and J. Tullis, of Kilbowie. The four washers in this part of the laundry obtain their power from a system of overhead shafting driven by a 10 horse-power Lundell motor, as may be seen in Fig. 4, which gives a plan of the wash-house.

Passing on through the doors of the separating partition, the large wash-house is reached. A plan of this is given in Fig. 4. Just inside the doorway on the left are some large solution tanks, where the water may be softened or solutions of soap or soda prepared. Steam pipes are laid on, so that, if necessary, the contents of these tanks may be boiled. Further on there is a series of nine washing machines, driven from a system of overhead shafting, which is put in motion by a 10 horse-power motor. Here, for a moment, we may digress in order to call attention to the system adopted for starting up the various motors throughout the laundry. Each motor is provided with a locked box with a glass door. This box, which is lit by an incandescent lamp, contains ordinary rheostat starting arrangements, with overload and no-load automatic cut-out switches. Unless the authorised attendant who is in charge of the motors, and who possesses the keys of the boxes, does it, no one can switch on a main motor driving shafting. The chance of accidents of all kinds is by this means largely diminished. The motors can, however, be switched off by anyone, for there is a further switch, to which all have access, and by means of which the circuit can be broken should the need arise. The motor, however, cannot, as we have said, be started again save by the responsible man, because of the no-load cut-out, which also opens the circuit when the current ceases to flow. It is worthy of notice that the motors used in the laundry for driving shafting are coupled directly to the shafting. They are reported to have worked exceedingly well, to have required a minimum of attention, and to have given practically no trouble whatever since they were installed. They run at 200 revolutions per minute, and use carbon brushes.

Returning now to the main wash-house, there are, as we have said, nine mechanical washers—eight large and one smaller. These washers are worked on a somewhat different system to those which we have just described, though there are many points of similarity. The outside casing is made up of wrought iron plates, and the end pieces which carry the bearings are of cast iron. The bearings are fitted with automatic grease lubricators. Unlike the foul washers, this outside casing does not revolve, but there is a cylinder inside which does revolve. It is inside this that the clothes to be washed are

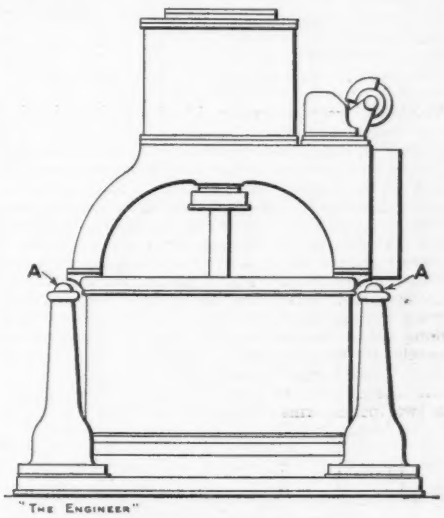


Fig. 3—DIRECT-DRIVEN HYDRO

placed. The cylinder is made up of sheet brass, and is pierced with a large number of holes. It is further provided with V-shaped projections on its inside to turn the clothes over and over. It revolves first in one direction and then in the other, as do the foul washers, but the water and steam and soap, &c., are taken into the machine, not through the trunnions, but through holes in the outside casing. It has not been considered necessary to lead the waste water from these machines through traps. As a fact the waste simply flows out into a yard where there is a large sump, the overflow from which eventually finds its way into the sewers. Two washers out of the nine are apportioned to flannel goods and the treatment is, of course, different in each case. For use in conjunction with the washers, &c., are five galvanised iron tanks, fitted up with hot and cold water supplies, and connected to the steam main. These tanks are for mixing and holding solutions of soap, soda, soft soap, blue and starch. Close by is also a small boiling tank, where small goods may be boiled, if it is necessary.

There is a battery of seven hydros. Three of these placed side by side in the far left-hand corner of the wash-house, as seen on the plan, Fig. 4, are of the self-contained type, and are motor driven, the motor being coupled to the spindle above the machine, as shown in Fig. 3. These machines are 26in. in diameter, and were made by Messrs. Summerscales, of Keighley. The motors,

which are totally enclosed, are of 4 brake horse-power each, and they drive the hydro spindles at a speed of 1100 revolutions per minute. The starting resistance and switch are contained in boxes on the machine frame. The switch is provided with a dashpot, so that the current cannot be turned on too suddenly. So as to take up the vibrations the bodies of these machines are slung on hangers provided with balls at their ends, these balls fitting into cups on vertical uprights, as shown at A A in Fig. 3, the uprights being hollow, and the hanger spindles passing up through them.

do not therefore come directly into gear with each other, and only do so through the two auxiliary wheels. The bearing of the upper roller is loose in its guides, and has a certain amount of lateral motion. The result of the whole arrangement is that, practically speaking, the gear wheels remain in the same degree of mesh, no matter what is passing through the wringer, all that happens being that the top roller is drawn rather over to one side while wringing is going on.

The floor of both the wash-houses consists of a serving of 1in. of asphalt put on over concrete, the latter being

to be ironed or mangled—has to be put on the drying horses for a longer or shorter time. These horses are 8ft. long and 6ft. high. They can be run in and out of their chambers, since they work on wheels and rails. The chambers are divided into three sets of fourteen, and each chamber is separated from that next to it by a galvanised iron chamber. There are three motor-driven Sturtevant fans drawing their air supply up sheet iron ducts from the engine-room below. This method of procedure not only has the advantage of cooling the engine-room by ventilation, but of obtaining the air in a somewhat heated con-

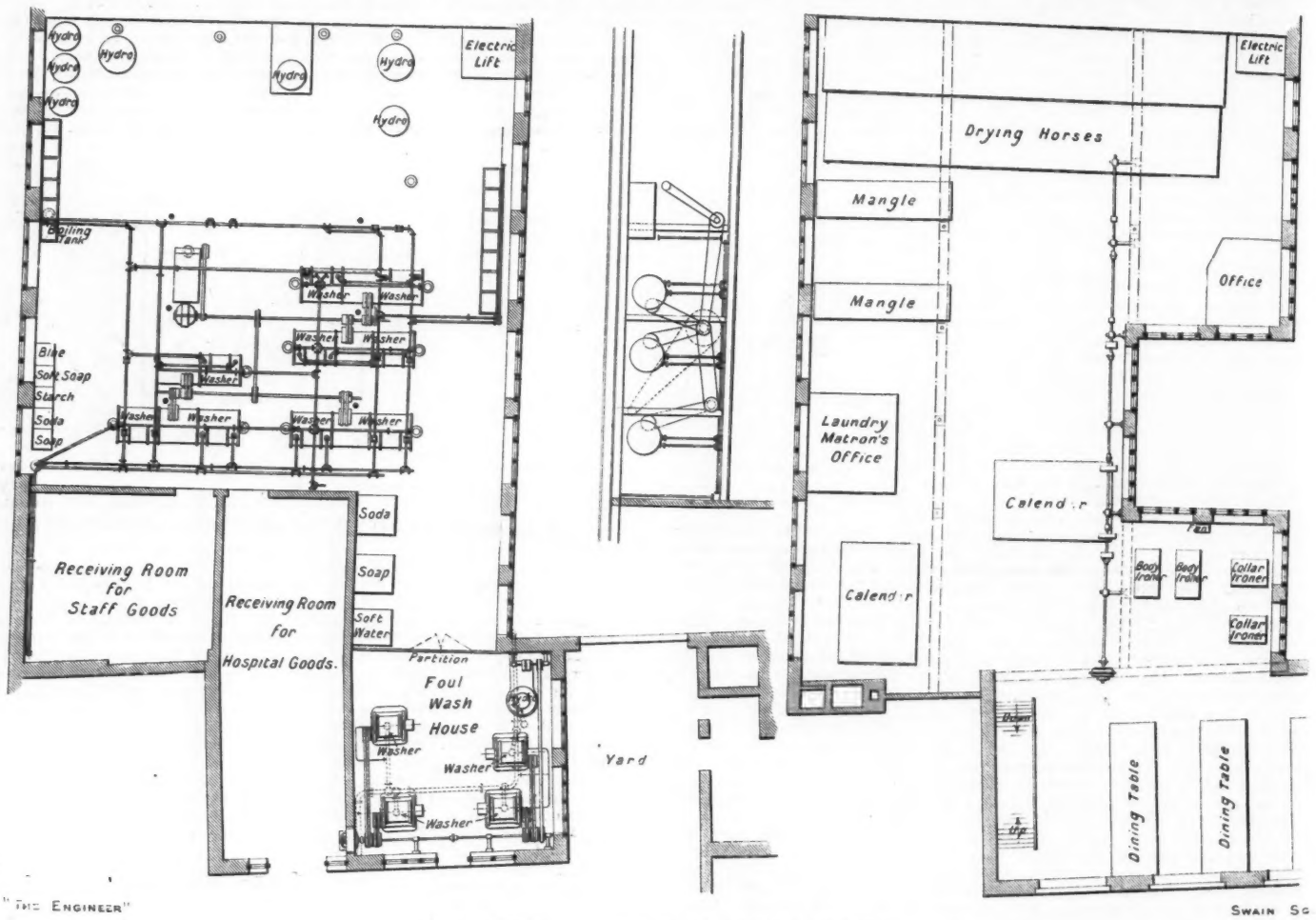


Fig. 4—LOWER AND UPPER FLOORS OF THE LAUNDRY

The linen is carefully arranged in the revolving bowls of these hydros with the object of balancing them as accurately as possible—a precaution which is needed, since if it is not attended to serious vibrations may be set up. There are three other hydros of a nearly similar type, but 36in. in diameter. They are by the same makers. They are not hung on ball bearings, but are simply laid on the floor, and not bolted down. Pegs are employed to prevent them moving from their position, but there is no attempt at fastening. The machines are all provided with lugs and bolt holes, but it has been found by experience that they work much better without them. These larger hydros work at 850 revolutions per minute. The seventh hydro is 30in. in diameter, under-driven, and is exactly similar to, and by the same maker as that in the foul wash-house already described. To complete the machinery in use in this wash-house there is a power-

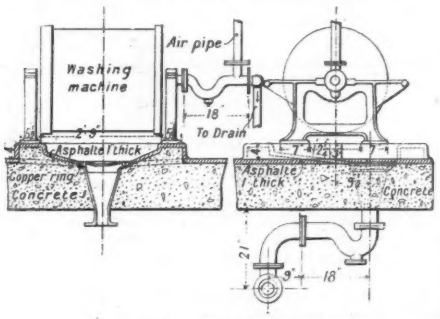


Fig. 5—DRAINING ARRANGEMENTS

worked wringer, driven by ingeniously arranged gearing, so that the teeth are always practically in full mesh, instead of, as in most machines of this type, the teeth of the top roller being nearly taken out of mesh when articles are passing between the rollers. The means by which this is brought about are as follows:—The bottom roller is fixed in bearings, and its gear wheel does not move either horizontally or vertically. Placed at its side, and gearing with it, is another wheel, which engages with a further wheel placed immediately above it. This wheel not only gears with the driving pinion of the upper roller, but is connected to it by a link which always keeps the centres of the two wheels at the same distance apart. The toothed wheels of the two rollers

laid on Ferguson's tubes. It was necessary to arrange matters so that by no possibility would water find its way through the floor down on to the machinery in the engine-house immediately below. In various parts of the floor there are drains passing through it, such as those required to take away the water draining from the washing machines. In order to prevent the water finding its way round the edges of these drains, copper rings, placed round them as may be seen in Fig. 5, and built into the concrete, were provided. Fig. 5 also shows

dition. The delivery of these fans is into a box containing steam coils. Each of the three boxes is connected to one set of drying-horse chambers, the air going along a trunk fitted with openings into each chamber. There is hence a means of controlling the temperature in the various sets of chambers, different materials requiring different temperatures. The discharge from the chambers is at the bottom at the back, and is made into a flue which leads into the open air.

On this floor there is a considerable amount of

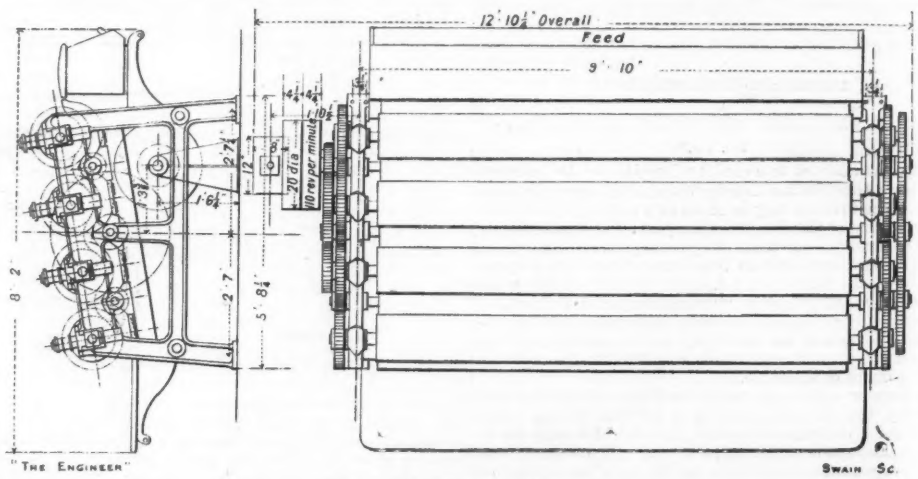


Fig. 6—CALENDERING MACHINE

the method of trapping. Whether or not there was any tendency to leak, it is quite certain that no water whatever finds its way into the engine-house. The ceilings and walls are all tiled. In addition to the washing machines, there are some dozen deep rectangular porcelain washtubs for hand washing. These are all provided with hot and cold water supply.

From this floor the linen clothes, &c., washed and partially dried, are taken up to the next floor—shown in plan on Fig. 4, above—by an electrically worked lift. Some of it is sufficiently dry to be taken to the calendering machines at once. A great deal, however—namely, that which has

machinery. For instance, there are two 110in. four roller calenders, made by Tullis. In these machines each roller has its cast iron bed steam heated, the steam being at 80 lb. per square inch. The pressure between the rollers and their bearings is adjustable. These machines deal with flat goods of all kinds. They derive their power from a 7½ horse-power Lundell motor, direct-coupled to overhead shafting. Then there are two Bradford's box mangles, which are machines which require no description. There are two collar ironers and two skirt ironers. These are machines with a revolving hollow cylinder, with gas jets playing on its inside surface, the jets being

produced with the help of compressed air. This roller bears on a table, which can be taken backwards and forwards. We were informed that, with a little help, one girl with one machine can iron all the collars and cuffs required for both Guy's and Charing Cross Hospitals. There are, as well, no less than thirty-two gas irons for working by hand. These are supplied with gas and air under pressure, and are highly satisfactory. The air pressure is obtained by means of a small centrifugal fan.

There are a number of features about this laundry which, are of great interest—such as the orderly way in which the garments, &c., are sorted and taken through the various operations without being mixed up, &c. These, however, do not involve any engineering processes, and we must content ourselves with saying that the whole is managed in a most business-like way, and the work well carried out. The design throughout is excellent.

THE INTERNATIONAL ENGINEERING CONGRESS AT ST. LOUIS.

No. I.

The holding of an international congress of engineering at the International Exhibition at St. Louis, was decided upon in the summer of 1903, and all arrangements for the Congress were entrusted to the American Society of Civil Engineers, who appointed a special committee to undertake the work. Invitations to participate in the proceedings were sent to American and foreign societies and to individual engineers, and special invitations to present papers on certain specified subjects were also sent out. The scheme covered all branches of engineering, but, in effect, it was strongest in relation to civil engineering, while electrical engineering was its weakest point, since an international electrical congress—also held in connection with the Exhibition—attracted most of the talent in this particular direction. All members of the American Society of Civil Engineers were *ex-officio* members of the Congress, while other engineer subscribers brought the total membership to nearly 3500. The number of persons registered as in attendance was 860, of whom about 660 were engineers, the others being ladies and other guests. Of the 660 engineers, 130 were from foreign countries. The total registration of 860 included 727 persons from the United States and Canada, 110 from Europe, 10 from South America, 10 from Asia, and four from Australia.

The meetings were held in the Congress Hall of the St. Louis Exhibition, a handsome granite building, which, after the close of the Exhibition, will be the library of Washington University. The opening address was delivered by Mr. Charles Hermany, president of the American Society of Civil Engineers, and an address of welcome on behalf of the Exhibition company was delivered by Mr. Skiff, director of exhibits. Sir William White, president of the Institution of Civil Engineers, then delivered a most interesting address, reviewing the development of the engineer and his work, and the important relation which his work bears to the benefit and welfare of the public. Short addresses were also given by M. Loicq de Lobel, of Paris; Oswald Erlinghagen, of Berlin; L. A. Huergo, of Buenos Ayres; K. A. Froman, of Stockholm; B. Bachmeten, of St. Petersburg; and O. F. Schoesberger, of Vienna. The various papers were classified under eight sections, the sections holding meetings simultaneously in different rooms. The opening meeting of the body at large was held on Monday, October 3rd. Section meetings were held on the four following days, and the closing meeting of the assembly was held on Saturday, October 8th. At this last meeting, the secretary, Mr. Charles W. Hunt, announced that 28 section meetings had been held, at which 97 papers were read. The printed proceedings will cover some 3500 pages. Closing speeches were made by Mr. Charles Hermany, for the United States, Sir William White for Great Britain, Mr. Karl Dahlstrom for Sweden, Mr. François Schule for Switzerland, Mr. O. F. Schoesberger for Austria, Mr. B. Bachmaten for Russia, and Mr. T. Shima for Japan. We propose to give a summary of some of the more interesting papers, and we commence with those on harbours and waterways.

HARBOURS AND WORKS ON THE SEA COAST.

Several papers were submitted dealing with the construction of harbours on the coast and the deepening and maintenance of those already in existence. There were many other papers dealing with docks, artificial waterways, and other cognate subjects, but at present it is intended to deal only with those relating to harbours. Out of twenty papers only three were contributed by English engineers, that of Mr. W. Matthews on "Harbours," Mr. C. Brereton on "Dry Docks," and Mr. W. H. Hunter on "Artificial Waterways." Generally speaking, these papers contain very little information that is not well known to engineers having special knowledge of the subjects dealt with, or that is not contained in the "Minutes of Proceedings" of the Institution of Civil Engineers, or in the pages of The Engineer.

Mr. Matthews' paper deals shortly with the question of littoral drift as affecting harbours on the coast, with pump dredging as used for the removal of sand bars and deepening the approaches. He refers to the revolution that has been brought about in the construction of sea works by the introduction of Portland cement and its use in place of lias lime, as formerly used; the development and perfection of plant and appliances, especially the machinery now used for moving and setting blocks of concrete of great weight. He expresses the opinion that, given a sufficiently extensive work to construct that will justify the use of the necessary plant, the most economical method of procedure in the building of sea walls is to use concrete blocks up to 40 or 50 tons in weight, and above low water to have these faced with granite. He describes the method adopted at Dover, for the purpose of preventing lateral movements of these blocks where they are exposed to heavy seas, of forming a continuous check or projection 6in. in height in each course, from low water downward, in the vicinity of the centre line, dependent on the bond thus raising the inner half, or harbour side, of each course 6in. above the seaward portion, and thereby creating a barrier to prevent movement shoreward on the occurrence of successive gales. Above low water the blocks are set and fronted in Portland cement and also bonded and joggled, and so are practically monolithic.

In this paper, a short description is given of the works now being carried on at the great Admiralty Harbour at Dover, which have been already fully described and illustrated in The Engineer; but an idea of the magnitude of these works may be gathered from the fact that the height of the extension of the Admiralty Pier—which is 2000ft. in length—from the foundation level to the top of the parapet is over 90ft., the depth alongide at low water being 42ft., exclusive of the sinking of the foundations below the surface of the natural sea bed; the rise of the tide is 18ft. 9in. Mr. Matthews refers to the "alarming reports" that have appeared in the Press with regard to the damage to the Dover works during their progress, but it is satisfactory to be told that practically no damage whatever has been occasioned to the permanent works, and only comparatively insignificant damage, having regard to the magnitude of the undertaking, has been caused to the temporary structures.

With regard to rubble-mound breakwaters, it may be of interest to quote the figures relating to the section of the one at Table Bay, Cape Town, which was designed and carried out under the direction of the late Sir John Wade. This breakwater is exposed to a specially heavy wave stroke.

Crest of the mound above L.W.O.S.T....	20ft.
Width of mound at crest	30ft.
Do. at base	360ft.
Slope to H.W.O.S.T....	2½ to 1
,, L.W.O.S.T....	5 to 1
,, 15ft. below L.W....	7 to 1
,, base	1½ to 1
Rise of S.T.	5ft.

In the paper by Mr. Wortman, "On the Construction of the Fishing Harbour at Scheveningen," is also described the method he has adopted for the same purpose. There the blocks are set in three courses, those of the middle range being in advance of those at the sides by more than half their thickness—say, 2½ft.—and so avoiding continuous transverse jointing. The blocks in the middle course are made 3ft. 4in. broad, and those at the sides from 6ft. 7in. to 8ft. 2in., according to the width of the breakwater. The maximum weight of the blocks is 26½ tons. The blocks at the sides are tied together, and fastened to those in the middle by strong iron bars.

Mr. Wortman's paper contains an account of the construction of the fishing harbours at Ymuiden and Scheveningen. Incidentally mention is made of the fact that in order to maintain the depth in the North Sea Harbour of Ymuiden an average quantity of 785,000 cubic yards of sand and silt deposited in it from the sea has to be dredged annually at a cost of about £12,000. The extension of the harbour in 1903 made necessary the construction of a quay wall or landing stage. This stage was constructed of concrete and steel. Instead of using piles and girders of concrete and steel as adopted by Mr. Hennebique at Southampton and other places, the girders here are supported by a double row of hollow pillars, which are moulded of concrete and steel on the adjoining ground, and afterwards carried by a traveller or floating jib to the spot where they are to be sunk. These pillars have a height of 28ft. 8in., and a diameter of 8ft. 2½in. They are spaced apart 16ft. 5in. centre to centre, the two ranges being 21ft. 4in. apart. The sinking of the well for fixing the pillars, which are placed partly in the water and part in the sand, is done in the following manner.

At first an additional cylinder, 12ft. 4in. diameter, made of reinforced concrete and provided with a steel edge, is sunk 26ft. below sea level in the sand by water jets, supplied by fifty injection tubes ranged along the outer side of the cylinder, the water being pumped under a pressure of about three atmospheres by two Pulsometer and three special pumps. When the cylinder reaches the proposed depth, the sand in it is removed by a sand pump, then the pillar is carried out by the floating jib, placed in the cylinder, and filled with sand, after which the cylinder is withdrawn to be used again. The sinking of the pillar has not met with any serious difficulties, as the soil consists of sand with a few layers of clay. On an average one pillar per day is sunk. Between the pillars of the back range, plates of reinforced concrete are inserted in the sand to the depth of about 24ft., thus forming a wall to prevent the sand behind the landing stage from sliding. The girders and deck plates are of reinforced concrete made on the spot. The basin along the work is to be dredged to a depth of about 20ft. below sea level. The landing stage is designed to carry locomotives of 45 tons weight. The cost of the work runs out at about £55 10s. per yard, as compared with £96 per yard for a similar quay wall of brickwork.

In order to comply with a condition imposed by the War Department, the pierheads of the outer harbour at Scheveningen are so constructed that they can at any time be destroyed by dynamite in time of war, and six mine tubes are placed in each pierhead, 24½ft. apart. In order to provide for these, and at the same time for bonding against horizontal sliding, three large steel caissons filled with concrete are placed in each pierhead. These caissons are fixed at a depth of 13ft. below sea level, their length being 49ft. and their width from 20ft. to 25ft. They are made of steel plates ½in. thick, and divided into ten compartments, each of which is provided with an orifice to let in the water when the caisson was ready for sinking. These caissons were built at Amsterdam, and towed through the canal to Ymuiden, and thence by sea to Scheveningen, the sea distance being 28¼ miles. A draught of 8½ft. was obtained by filling them partly with concrete. It took from five to six hours to tow them round. When placed in position, the orifices were opened and the caisson sunk on to the bed which had been prepared for it, and then filled with concrete, the complete filling occupying forty-eight hours. The transporting and sinking was, on the whole, satisfactorily accomplished; but one cylinder, when ready for sinking, was thrown off its anchor by an unexpected rising of the waves, and shipwrecked on the coast; and on another occasion, owing to a sudden gale springing up when the filling had just been completed, some damage was done to the cylinder, which was subsequently repaired.

A paper by Major Gillette dealt with the "Sea-coast Harbours on the coast of America." From the description of the works given it appears that there are only two methods of bar deepening that are adapted to the sandy coasts of the United States. These are dredging, and twin jetties, constructed either together or with the windward one in advance, both carried to high water far enough from the shore to arrest the sand drift coming from that side, the lee jetty having such length and location as to hold the ebb flow up to its work. The choice between these two methods depends on the cost in each particular case. If the cost of maintaining the channel annually by dredging is less than the interest on the cost of the permanent improvement, dredging is, in the writer's opinion, the proper method, as the contingencies are less and there is always the probability that, once a deep navigable channel is created, its maintenance would be very materially reduced, if not eliminated entirely, whereas with jetties there is always the risk, if not the certainty, of the bar re-forming seaward. With regard to this, Major Gillette says that there is no method yet devised, except dredging, that will not push the bar forward; and while twin jetties are the most successful structural agency for removing bars, they are doubtless the worst sinners in this respect. He therefore believes that for the future the Atlantic coast harbours can be most economically improved by dredging alone, and that, had sea-going dredgers been perfected when the jetty system of the older harbours was started, the interest on what these have cost would have dredged deeper and more capacious channels than the jetties have produced.

The same conclusion seems to have been arrived at by Mr. Matthews, for in his paper, before referred to, where he remarks that works constructed for the improvement of bar harbours which, before the introduction of pump dredging, were only partially successful, have, in consequence of the aid afforded by suction dredgers, now become thoroughly satisfactory in the effects produced, and he instances the ports of Durban and East London. At the latter place the depth of the entrance in its natural condition was only 5ft., with 5ft. rise of tide. Now, owing mainly to the use of suction dredgers, steamers of 5000 tons can enter and leave the port. He points out that the great advantage of this type of dredger is that they can work in a seaway where the use of a bucket dredger would be quite impracticable. And he is further of opinion that not only has suction dredging already had an important influence in the improvement and deepening of harbours, but that it will have a still more important influence in the future.

The paper by Major J. C. Sanford on the "Dredging of Ocean Bars" confirm these views from his experience, not only on the coast harbours of the United States, but also with those on the Great Lakes. A decided change of view has taken place amongst the American engineers as to the necessity for constructing expensive permanent works for the purpose of deepening channels over bars. It is now believed that for most localities the proper function of jetties is to protect and maintain a channel after this channel has been produced by dredging. For other localities where the littoral movement of sand is small, it is believed that no jetties at all are required, as a channel can be produced and maintained by dredging at a cost far less than that of constructing and maintaining jetties. Where the littoral movement is great a single jetty on the windward side may be necessary. Experience in America shows that suction dredgers are by far the best adapted for work on exposed ocean bars, and possess marked advantages for the maintenance of channels in rivers and other sheltered waters.

Major Kingman, in a paper on "Harbours on Lakes Erie and Ontario," referring to the increasing size of vessels, states that whereas a depth of 8ft. or 10ft. was sufficient for the earlier commerce on the lakes, this had to be increased as the population on the lakes increased and industries grew up, to 12ft., then to 16ft., and now a minimum of 21ft. is hardly deemed sufficient. The jetties made originally of timber crib work have long since lost their primitive function of scouring out a channel by the natural force of the currents and have become simply conservative, their office now being to protect the artificial channels which have been secured by dredging.

As population has increased and the cultivation of the land extended timber has become scarce and more costly, and thus deprived it of the advantage that it at first possessed of being easily obtained and cheap. The well-known crib system of constructing the piers and breakwaters of the Lake harbours has now given place to rubble mounds of stone or concrete structures.

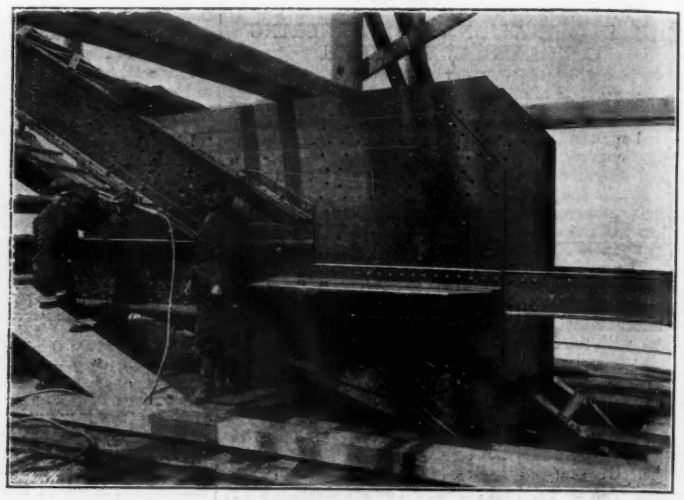
Glasgow University Engineering Society.—The following is a syllabus of the remaining meetings for the present session arranged by this society:—November 24th, "Methods of Estimating the Cost of Machinery," Mr. Alex. Cleghorn (Messrs. Barclay, Curle and Co., Limited); December 8th, "Some Notes on Sewage Works Plant," Mr. A. Home Morton, A.M. Inst. C.E., A.M.I.E.E.; January 13th, 1905, "Gas Producers," Professor T. Gray (the Glasgow and West of Scotland Technical College); January 26th, "The Commercial Efficiency of Prime Movers," Mr. A. M. Downie, B.Sc., A.M. Inst. C.E. (Messrs. D. Stewart and Co. (1902), Limited; February 2nd, "Some Details of Albion Motor Cars," Mr. T. Blackwood Murray, B.Sc.; February 16th, "Some Problems of Electric Traction," Mr. Theodore Rich, A.M. Inst. C.E.; February 23rd, "German Shipyards," Mr. C. S. Douglas, B.Sc., M.I.N.A. (Messrs. J. Brown and Co.); March 2nd, Annual Business Meeting. Meetings are held in the James Watt Engineering Laboratories at 7.45 p.m. on the dates indicated. The Hon. President, Mr. W. A. Chamen, M. Inst. C.E., delivered his address on the 3rd inst.

NEW BRIDGE NEAR MAYENCE.

The new bridge briefly described in this article forms the most remarkable part of an extensive construction work that has just been completed, effecting on one hand a direct connection between the railways on the right and left bank of the Rhine, and on the other an opening for goods traffic from Mayence towards Frankfurt or Darmstadt.

It has long been felt that a tunnel, 1196 m. in length, with only two tracks, immediately south of the Mayence Station, and passing below the citadel, constituted an insurmountable obstacle to the development of the Mayence traffic. Now neither Mayence itself nor this tunnel will in future be traversed by the goods trains arriving from Bingen, these being led across the new two-track railway bridge, traversing the Rhine below Mayence, near the Flosshafen, and across Petersaue Island whence they will proceed as far as Bischofsheim,

DISCHARGING SCAFFOLDING

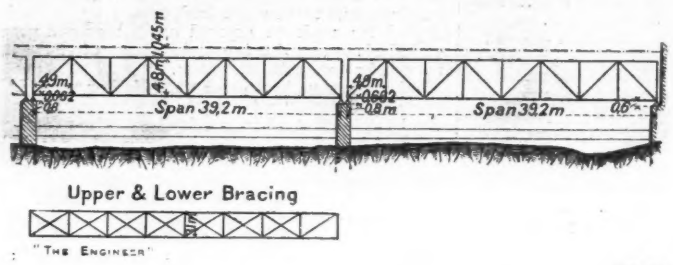


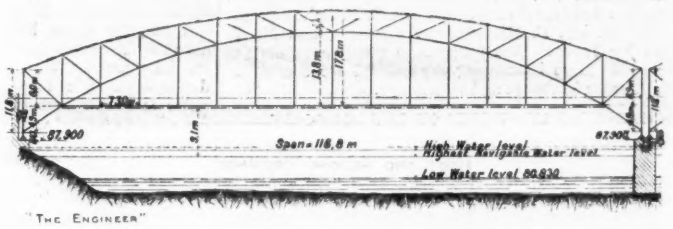
CONNECTION OF TIE TO UPPER FLANGE

on the right bank of the river. Only local goods intended for Mayence itself will be eliminated at the Bischofsheim or Mombach branching stations to be conveyed immediately to Mayence. By means of curved connections from the bridge to the existing railway lines on the right and left banks of the Rhine River, it is now possible to run through passenger trains, thus allowing of an immediate connection between Wiesbaden and Mayence being effected. The want of this has been keenly felt on account of the lively commercial relations existing between the two cities. There are, further, some very obvious advantages from a military point of view.

The construction of this bridge, which has entailed a cost of 5·1 million marks, was entrusted to Messrs. Philip Holzmann and Co., of Frankfurt, the design of the iron constructions being undertaken jointly by the Union Company, Dortmund, and the Gustavsburg Works of the Consolidated Augsburg and Nürnberg Machine Shops. The latter took charge of the bridging of the left-hand arm of the river, divided by the Petersaue Island, and of part of the flood bridge, the remainder of the latter, as well as the bridging of the right-bank arm of the Rhine, being carried out by the Union Company.

The left-bank arm of the river is traversed by three framework arch girders, 93·8 m. and 107·2 m. in span, and the right-bank arm by two framework arch girders, each 116·8 m. in span. In order to bridge the Petersaue Island, six framework spans with parallel flanges, and upper roadway





DETAILS OF SPANS

of a length of 39·2 m. each, were adopted, the total length of the bridge, including the terminal abutments, being 915 m. The bridge rests on sixteen piers. The foundations for the flood piers had to be constructed by means of compressed-air. The main girders of the river bridges are designed as framework-arch girders, including ties for dealing with the horizontal thrust. The roadway is suspended freely, so as to avoid, as far as possible, any prejudicial secondary and additional stresses which might arise from the rigid connection of the different parts of a bridge when riveted together.

The roadway is intended both for the double-track railway traffic and for the passage of military carriages. On both sides of the main girders there have been provided footpaths intended for the public traffic. The total iron weight of the bridge is about 7000 tons. In addition to the construction of the right-bank half of the bridge, the Union Company supplied the caissons necessary for the foundations of the flood piers. The short period required for the installation work is worth mentioning. As regards the three flood openings, comprising about 600 tons of material, their installation was carried out between January 1st and April 1st, 1903, while the installation of the two river openings, necessitating the putting in position of about 2600 tons of metal, was effected between April 6th, 1903, and October 8th, 1903.

Our engravings show views of different parts of the bridge and examples of the two types of spans. For these our thanks are due to the managers of the Union Company, Dortmund, who also kindly supplied the data from which the foregoing article has been prepared.

DIAMOND JUBILEE OF THE CHEAP TRAINS ACT.

On November 1st, 1844, there came into force upon most British railways the provisions of an Act passed on the 9th August in the same year, whereby the third-class traveller was first given a legal status. Prior to this, the companies could take him or leave him as they chose, or carry him in any sort of vehicle, at any hour or speed they liked. Their practice varied greatly in this respect, but all were agreed that high fares and the worst possible accommodation were sound policy. Fares were from 1½d. to 1½d. per mile, for which often merely standing room in seatless and uncovered trucks was provided. The Cheap Trains Act made compulsory one train each way on week-days on every passenger line, at a fare not exceeding one penny per mile. Covered and seated coaches were to be provided, and a speed run of not less than twelve miles per hour, including stoppages, for the whole length of the journey. Where any trains ran on Sunday these regulations applied to the one stopping at the greatest number of stations. The hours at which such trains ran were to be approved by the Board of Trade, as were the vehicles employed, and the trains were to stop at all stations if required. Passengers might carry half a hundredweight of luggage each, free of charge; children under twelve years old went at half price, and under three gratis.

The railways received this enactment, as a rule, in a very ungracious spirit. They had hardly begun then to fear competition, and were enjoying their monopoly to the fullest extent. Poor people never had travelled; why should they begin? The Act was considered a distinct breach of faith, consequently its provisions were made known as little as possible. In fact, it was turned to the public disadvantage in many cases, except as to the rate of fare and style of accommodation. On the Brighton line no train had been slower than 2½ hours, at a third-class fare of 5s., but now the unfortunate "Parliamentary" passenger—as he soon got to be called—had to start at 6.30 a.m., and did not reach Brighton till 9.55. A similar train—both were "mixed goods"—ran at the same hour, and took five minutes longer, in the opposite direction, but the alteration was welcomed at Brighton as bringing the newspapers down an hour earlier than before. The coaches used are described as "enclosed from the weather by wooden slides. The seats run from end to end, like those of an omnibus," about forty being accommodated.

The South-Eastern, on its part, "took it out" of the Dover people severely. The first down train, which was also one of the two through third-class trains which were run daily in each direction, had left London Bridge at 8.0, reached Dover, 88 miles, *vid* Redhill, at 11.58. It now left at 9.0, and took twenty minutes longer, arriving at 1.18, the fare being raised sixpence to the Parliamentary standard. Otherwise this company was unusually enlightened, the Sunday trains to and from Dover being all third-class, except the night mails. All the Sunday trains to Brighton at this time were third-class.

Another line which apparently took the Act much amiss was the Eastern Counties. Two and a-half hours had been the slowest time between Shoreditch and Colchester, 51 miles, where the line then ended, but this was now made very nearly four hours. As the down train left at 7.45 a.m., and the up at 5 p.m., it was no longer possible to get from Colchester to London in time for business by third-class, which had been easy before by a 9 a.m. up. As the third-class fare had been no less than 7s., the company's disgust at a to lean upon that the occupants had practically to rest against each other. Vehicles of this type were to be found on the London and South-Western occasionally, down to about 1878, even in suburban traffic.

At Paddington the third-class passenger had always been severely repressed. Not for him were the vaunted glories of the broad gauge; nor, indeed, for the second-class traveller either. Thirds had always been conveyed by goods trains only, in open vehicles, and largely at night. Just prior to the Act coming into operation the service had consisted of two such trains each way, leaving London at 4.30 a.m. and 9.30 p.m., Bristol at 2.30 and 10.0 p.m. The night trains continued to take thirds, but in place of the others regular passenger trains left Paddington on and from November 1st, 1844, at 7.0 a.m.. and Bristol at 9.30 a.m. Both took about 9½ hours on the journey of 118 miles, so that they only just came within the requirements of the law as to speed. On the Bristol and Exeter, which was then worked by the Great Western, the one Parliamentary train each way connected, with a long wait at Bristol, only with the night goods train, so that it was quite impossible to get through over the 194 miles in daylight. Five to five and a-half hours were taken over the Exeter section of 75½ miles. It is probable they were goods trains, the down left Bristol at 7.0 a.m.; and on August 3rd, 1844, the company had advertised in the *Times* that "the goods train at 7 o'clock from Bristol to Tiverton-road will not carry any first or second-class passengers." In view of the present train service it seems almost incredible that such arrangements can ever have really existed.

A few lines, the London and Birmingham, Grand Junction, and York and North Midland, for instance, announced that the penny-a-mile scale would be instituted on October 1st. The two former put the trains through between London and Liverpool, 210 miles, *vid* Newton Junction, in 15½ hours, with half an hour's wait at Birmingham in the afternoon. This was the more liberal, as they did not come under the operation of the Act just then, but would have done so later on. The Birmingham Company's thirds were originally known as "the blue boxes," and doubtless resembled those in the well-known coloured views of early Liverpool and Manchester trains. This line and several others made no alteration in the times of its third-class train service.

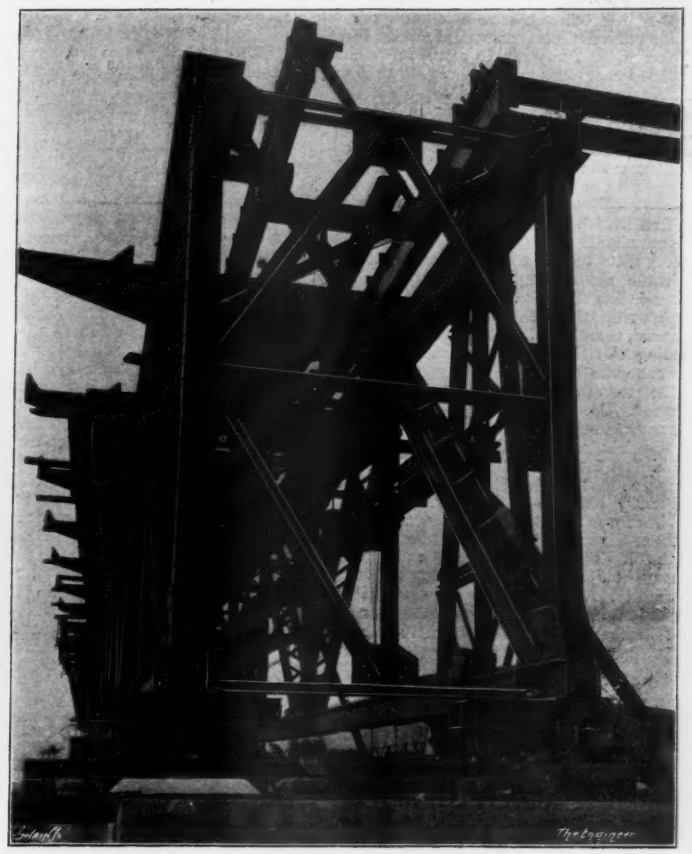
The Cheap Trains Act, though short, contains some extremely important provisions, including the one authorising the Treasury to purchase future lines, under certain conditions, a clause which, if carried out, might have entirely altered the present relations between the railways and the nation. The late Mr. Gladstone was the author of the Act in question, which was often, in fact, named after him.

A movement is now on foot to organise a company for the purpose of building an electric railway at Rosario, a city of about 122,000 inhabitants, in the province of Santa Fé, Argentina.

RAILWAY BRIDGE NEAR MAYENCE

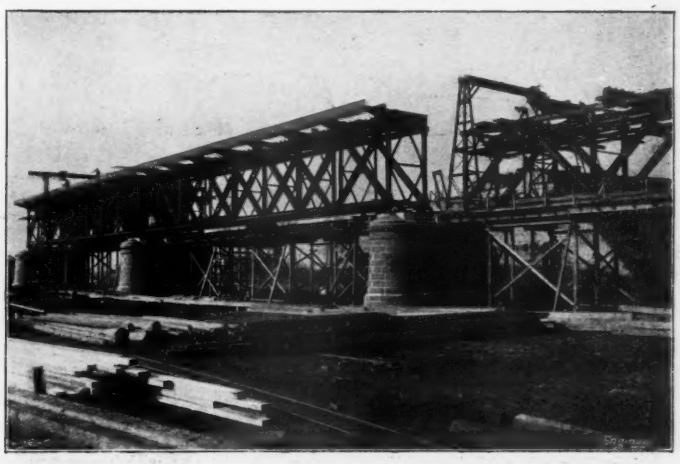
(*For description see page 468*)

MOUNTING SCAFFOLD FOR RIVER OPENINGS

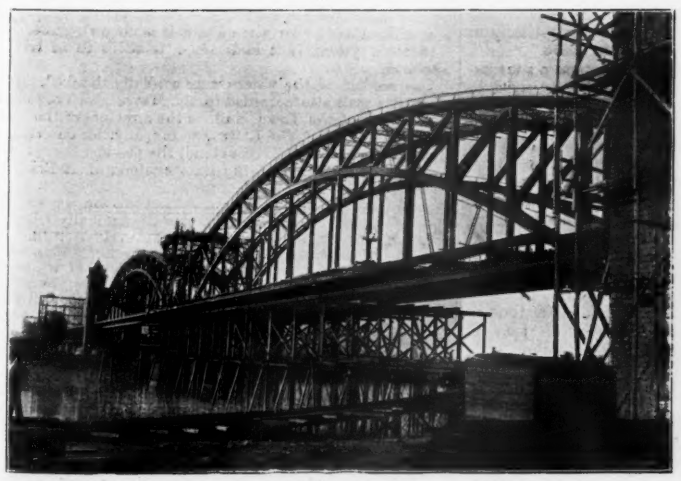


MOVING SPAN INTO POSITION

FIRST AND SECOND OPENINGS



MOUNTING FLOOD OPENINGS



REMOVING SCAFFOLDING—SECOND OPENING

COMPLETED SCAFFOLDING FOR RIVER OPENING

H.M. ARMOURED CRUISER BLACK PRINCE.

Those of our readers interested in the development of the British Navy will remember that they were informed in our issue of July 3rd, 1903, that early in the year the Admiralty had placed with the Thames Ironworks and Shipbuilding Company, at Blackwall, the order for the building of a first-class armoured cruiser to be called the Black Prince. The vessel to be thus named was to represent the latest ideas in warship construction, as she would be entirely the design of Mr. Philip Watts, the Chief Naval Constructor, and would embody in that design all the recent experience gained with a succession of British cruisers, commencing with the Drake, and ending with the Devonshire. It was also announced just prior to the laying down of the first keel plate of the Black Prince, which took place on April 28th, 1903, that she would be the first British warship to be entirely completed ready for commission at the builders' works.

Very little was done in the direction of making a start with the actual construction of the hull of the Black Prince in the first three months of 1903, for, being the longest ship the company has ever had to build in its shipyard, some 70ft. had to be added to the length of the building slip on which she was to be constructed to accommodate her, which necessitated some further piling on the ground under the additional keel blocks that were required. So, after some considerable delay caused by this work, and that occasioned by the system introduced by the Admiralty, of endeavouring to standardise the machinery, fittings, &c., of vessels of the same class and design, so that they could be interchangeable—not having previously been so—only about 350 tons of material had been worked into the ship by midsummer of 1903.

Up to the end of September of that year, although work on the ship had not progressed as it should have done, because of the difficulty of getting details settled at the Admiralty, over 1000 tons of steel material had been worked into her. By the end of the year fairly good progress had been made with her structure under the new conditions, a further 1350 tons weight of material having been added, and advancement towards completion for commission steadily forwarded.

During the first three months of the present year the progress made in building had not been so rapid as was hoped, by reason of the many modifications introduced in the vessel's design internally; but in so far as the hull was concerned, very fair progress had been made, some 1500 tons, which included about 200 tons of armour, having in the meantime been worked in, the progress of the fittings, however, not being at all on a par with that of the hull. The following three months, however, showed better progress made than for some time past, as the armour for the vessel had been coming to hand very rapidly, some 900 tons having been fitted in place on the ship as fast as delivered, so that at the end of last June 5000 tons of material had been worked into its assigned position in the ship's structure.

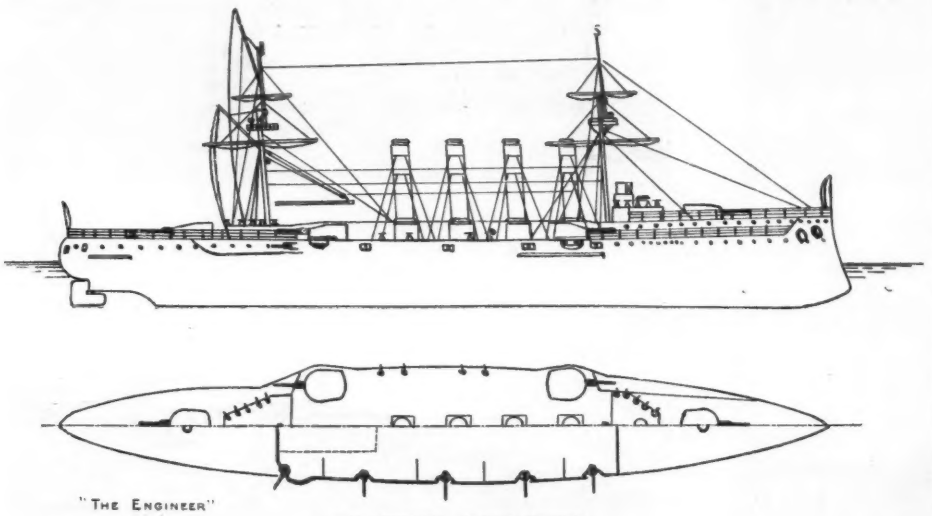
Premising that the hull of the Black Prince is built throughout of mild steel, her principal dimensions are as follows:—She is 480ft. long between perpendiculars and 505ft. over all, her extreme breadth is 73ft. 6in., and she has a depth from outer bottom to upper deck of 40ft. 9in. Her draught will be 26ft. 6in. forward and 27ft. 6in. aft, at which her displacement will be 13,550 tons. She has a complete armour belt running from stem to stern, the thickness amidships at the water line being 6in., tapering to 4in. at the forward end and 3in. at the after end. The citadel or battery, as will be seen by our sketch in profile and plan, Fig. 1, is rectangular in shape, protected by 6in. in thickness of armour, and its position in the ship is about midway of her length on deck. In it will be carried ten 6in. guns, eight of which are broadside guns, while the two after pieces can fire both athwartships and fore and aft; all these guns being separated from each other by steel splinter bulkheads 2in. thick.

On the upper deck there are five 9·2in. guns in barbettes, protected by 6in. and 3in. armour, while forward on the forecastle is another 9·2in. gun, making six in all. The foremost and aftermost 9·2in. guns are situated at the middle line of the ship, so that they will command an arc of fire of 310 deg. The other four 9·2in. guns are placed at the sides of the ship, and nearly over the ends of the citadel, each commanding a range of fire of 180 deg.

The shelter decks are well armed with 3-pounder quick-firing guns, some twenty-eight in number. For boat and field use there are also provided two 12-pounder 6-cwt. guns and two Maxims. The battery has a protective deck covering of steel 1in. in thickness, which is continued forward on the main deck. In addition to this, there is the usual high-cambered steel protective deck, ¾in. thick at the water-line, running right fore and aft. The conning tower is of steel, 10in. in thickness, provided with the usual armoured tubes for carrying the leads of shafts, pipes, &c., from the shelter deck to within the armour protection. The whole weight of armour is about 1600 tons, exclusive of the protective decks.

One of the new features in the design of the vessel internally is the placing of the shell-rooms in the ammunition passages, close to the ammunition hoists, thus saving much time in getting the shells to the guns. The 6in. ammunition hoists have electrical motors, while those to the 9·2in. guns are worked hydraulically. In addition to the armament detailed above, the ship is fitted with three 18in. torpedo tubes, one on each of her sides, and one at the stern, all under water. The stem, as will be seen in our sketch, Fig. 1, is ram shaped, and is materially strengthened by the protective deck being carried right up to the ram, and secured to it. Her double bottom is made for carrying heavy oils, and is fitted with pumps, pipes, filters, &c., to enable oil to be used as fuel in her boilers, if necessary. The ventilation of the ship is effected by electrically-driven fans, and she is lit up with about 1400 incandescent lamps, and is well served with electrical bells, telephones, &c.

The Black Prince is steered by a balanced rudder, which is actuated by steering engines of Messrs. Bow and McLachland's make. She has two capstans, one forward, driven by steam, and one aft, electrically. Her anchors, five in number, are three of them of Wasteneys Smith's stockless type, the others a stream and kedge. The ship will have four funnels and two masts, as shown in the sketch, but no fighting tops, and there will be six electric searchlights. Thirteen boats will be provided, which will include two steam pinnaces, and a Balsa life-raft.



H.M. CRUISER BLACK PRINCE

The launch of the Black Prince took place on Tuesday last, she having been transferred from the slip on which she was built about 1.45 p.m. on that day into the very narrow waterway known as Bow Creek, which is not more than 400ft. wide at its riverside entrance, the putting her safely afloat—an operation, considering her dimensions, of which those concerned may justly be proud—having been accomplished without the slightest hitch.

The ceremony of naming the vessel was performed by Lady Selborne, wife of the First Lord of the Admiralty, who, with her husband and several distinguished personages, were assembled on the platform at the head of the vessel. The few remaining keel blocks under the vessel having been knocked away, and all being in readiness, the dog-shore cord was cut by Lady Selborne with a silver knife, thus removing the last remaining impediments that held the ship stationary on the ways, down which she proceeded, and took the water majestically in little more than a minute from starting to move.

In addition to the great care taken to ensure a successful launch, considerable expense had to be incurred in effecting it. Her launching weight being about 6500 tons, necessitated substantial launching ways and a strong cradle. The former were in this case 392ft. and 465ft. in length for the "sliding" and "ground" ways respectively, which were made of pitch pine logs and American elm planks, their distance apart from out to out being 27ft. and width 5ft. each; the mean declivity of the ways being ¾in. per foot of length. The cradle which carried the ship down the ways to the water weighed about 300 tons, giving, with that of the ship, a gross superincumbent weight of about 6800 tons, or a pressure of 1¾ tons on each square foot of surface of the ways, and 700 tons on each of the foremost poppets. About seven tons of lubricating material in the shape of Russian tallow, train oil, and soft soap, were used on the sliding and ground ways in launching the ship, and the cost of putting her into the water is about £2000. Her launching draught is 16ft. 3in., she already having all belt armour in place, as well as a portion on the sides of the battery.

The whole of the launching arrangements in connection with the Black Prince were under the direct personal superintendence of Mr. Clement Mackrow, the very able shipyard manager and constructor to the Thames Ironworks Company. The ship will be fully completed ready for commission in the Victoria Docks by her builders. She is to have a complement of officers and men to the number of 770 all told.

The propelling machinery of the Black Prince, which is of 23,000 indicated horse-power, and is now being constructed by her builders, we shall fully describe and illustrate in a later issue.

THE NEW SWALE BRIDGE.

In accordance with notices, which had been published far and wide, the railway bridge over the river Swale, at King's Ferry, was closed to all traffic on Sunday last. This was done for the purpose of enabling the contractors to remove the centre span, and to substitute therefor a steel bascule. This bridge, of course, serves as a connecting link between the Isle of Sheppey and the mainland of Kent. For the past two years the firm of contractors of Sir William Arrol and Co., in conjunction with the engineers of the South-Eastern and Chatham Railway Company, have been busily engaged in constructing a bascule, or roller lift bridge, to take the place of the span which was formerly raised for vessels with fixed masts navigating the Swale, but which, owing to suspected structural weakness, had to be riveted down. The engineers and contractors have had an exceedingly difficult undertaking, for the bascule had to be constructed at a sufficient height to permit the trains to pass underneath. On Saturday night the final touches were given to the work, under the personal supervision of Sir William Arrol.

The method adopted for the removal of the old span was as follows:—Two large lighters, each capable of carrying a weight of 200 tons, had been placed in position under the centre arch, and over these pontoons, so to speak, had been constructed a cradle of stout baulks of timber, built at such a height that, just before high water, the staging reached the level of the span that was to be removed. This portion of the bridge had been unriveted and detached beforehand, so all that remained was to wait until the tide rose sufficiently until the timber cradle reached the span. This happened shortly before 9.30, and in half an hour the span had been floated out by the tide clear of the bridge. The weight of the span removed was 190 tons, and its length 65ft. The old span having been removed, the work of lowering the ponderous steel bascule, weighing 350 tons, was commenced. Gradually, inch by inch, this was successfully lowered into position.

The new span is of the Scherzer rolling type. Formerly there were two spans here. Now the whole width of the centre arch is bridged by one span. This new lifting span—the construction of which, it is estimated, entails an expenditure of £50,000—was built to meet the requirements of the water traffic on the Swale. The bascule will be raised for the passage of vessels with fixed masts, an operation that requires to be done with as little delay as possible, so as not to interfere with the rail traffic. Over this bridge there passes not only considerable traffic between the important dockyard town of Sheerness and the Isle of Sheppey, and the main line, but this line is also in the direct Queenborough and Flushing route to the Continent. Underneath the bridge there is a large and important water traffic between Sittingbourne and Milton and the metropolis to study.

The bridge is to be raised and lowered by electric power. A power station is to be constructed near the bridge, the energy being supplied by two oil engines of 20 horse-power each. The engineer of the scheme is Sir Benjamin Baker, who has worked in conjunction with Mr. P. C. Tempest, chief engineer, S.E.C.R. Mr. Stainton, assistant engineer, S.E.C.R., has been the engineer in charge of the operations.

THE ASSOCIATION OF TRAMWAY OFFICIALS.

As already announced, the eighth general meeting of the Association of Tramway and Light Railway Officials was held at Wakefield on the 2nd and 3rd inst. Mr. H. England, general manager of the Wakefield and District Light Railways Company, the president for the year, was in the chair. A report of the proceedings on the opening day appeared in The Engineer last week. On the conference being resumed on the 3rd inst., Mr. F. Coutts, of Ayr, read a paper on "Systems of Ticket Checking," which had no engineering interest.

Mr. Alfred Raworth, of London, then read a paper on "Mr. Raworth's System of Regenerative Control." Mr. Raworth claims that under his system the various details of equipment are less complex, less costly to instal, and more economical in operation than the series-parallel system; further, that the regenerative control system gives absolute and perfect control of the car under all conditions of weather, and on any grade, whether the trolley is on or off the line. Mr. Raworth mentioned a further point strongly in favour of his system, viz., that as the braking is done by the motors, no mechanical brakes are required except for the simple purpose of holding the car when a stop is made on a grade. Mr. Raworth's system, it is understood, is about to be tried at Sheffield.

The readers of the papers were cordially thanked. Votes of thanks were also accorded to the Mayor and Corporation for the use of the Town Hall, to the directors of the Wakefield and District Light Railways Company, for entertaining the members, and to Mr. England, the president.

It was decided to hold the next conference at Bristol in April of 1905.

Association of Teachers in Technical Institutes.—At a largely attended and representative meeting of teachers from London polytechnics, technical schools, and schools of art, held at the Birkbeck College, on Saturday, October 22nd, Mr. W. J. Lineham—head of engineering department, Goldsmiths' Institute—in the chair, it was decided to form an Association of Teachers of Science, Art, and Technology, engaged in the Institutions mentioned above, such Association ultimately to extend its memberships to institutions in the provinces. A temporary Committee, consisting of Miss Bramham, Northampton Institute; Miss Maxlow, Wandsworth; Messrs. Bates, Brixton; Baxter, Boltcourt; P. Churchill, M.A., East London; J. B. Coleman, A.R.C.S., South-Western; P. Coleman, M.A., Northern, Draycott, Borough; Grimwood, Westminster; Harrop, St. Bride's; Lineham, M.I.C.E., Goldsmiths'; C. F. Mitchell, M.S.A., A.S.I., Regent-street; G. Paley-Yorke, M.A., Poplar; S. Starling, B.Sc., West Ham; Walters, Hackney; and J. Wilson, M.Sc., Battersea, was appointed to draw up rules and a constitution, and to report to a meeting to be held in January, 1905. A temporary subscription was fixed, and members were enrolled

RAILWAY MATTERS.

THE whole of the employés at the great engineering works of the London and North-Western Railway Company at Crewe, about 10,000 in number, are now working only four and three-quarter days per week.

THE French Minister of Public Works has authorised the Midi Company to open the line between Castelsarrasin and Beaumont-de-Lomagne, with the intermediate stations of Belleperche, Labourgade, Larrazel, and Sérignac.

THE Mansion House Association on Railway and Canal Traffic has arranged a meeting of traders early in December for the purpose of considering the proposals of its executive committee for placing canals and inland navigations under the control of one authority.

THE Birmingham City Council have authorised the Tramway Committee to proceed with a Parliamentary Bill for power to extend and electrify the city tramways, the existing portions of which have already been acquired. The scheme is estimated to cost upwards of £1,000,000.

A MEETING was held on the 2nd inst. at Barrow to consider the advisability of supporting the proposal to construct a new railway from Sunderland to Barrow by way of Darlington and Swaledale. The scheme was explained by Mr. F. Stileman, engineer, and a committee was formed to help forward the scheme.

RENDERED uncontrollable because of leaves on the track, a car of the Boston and Worcester-street Railway slid down a steep hill in Boylston-street, Chestnut Hill District, Newton, Saturday afternoon, October 22nd, and crashed into another car that was stalled at the bottom of the hill, wrecking both cars and causing painful injuries to eight passengers.

MORE than 1,000,000 people were carried by the St. Louis Transit Company on Veiled Prophet's Day, Tuesday, October 4th, establishing a new record that far exceeds any previous one made by the company. Adding the passengers transported by the St. Louis and Suburban Railway and by the Wabash shuttle trains, the figure reaches nearly to 1,500,000.

THE New York, New Haven, and Hartford Railroad Company is dismantling its third-rail line between Nantasket Junction and Braintree, and the announcement is made that the electrical equipment and operation of its suburban lines will not be undertaken until the invention of new appliances or the perfection of those now existing makes such a step more feasible.

A METALLIC wire brush has been invented that may be readily adjusted to either end of a railway carriage to keep the space between the rails clear of plant growth. When in use the brush is dropped so that wires will just scrape the ground, and when the car is in motion the brush will effectively cut the weeds. The apparatus is flexible and can be adjusted to any desired position.

IN connection with plans for the general improvement of its road and the reconstruction of its Hoboken terminal, the Erie Railroad is taking up the question of electricity for its suburban passenger traffic. The whole plan as regards electrification is vaguely indefinite so far as it has been made public, but is understood to provide for a change of power on not less than fifty miles of track.

ON the St. Louis and Suburban Railway the number of passengers carried during the quarter ending June 30th was 5,889,746, against 4,451,164 last year. The number of trips last quarter exceeded the corresponding quarter of last year by more than 3000, 77,743 trips having been made, against 74,563. The gain over the previous three months of the present year also shows a great increase of traffic.

IT is understood that the Russian Riazan-Uralsk Railway Company has had to abandon its intention of connecting Astrakhan, at the mouth of the Volga, with the rest of its system. Engineering difficulties are given as a reason. The cost of building heavy permanent embankments and huge bridges over the arms of the Volga is considered to be prohibitive, and the financial strain on the Russian Treasury renders economy particularly expedient at the moment.

THE railways of the United Kingdom at the close of last year owned 22,276 locomotives, and 801,926 passenger carriages, wagons, and other vehicles. In the total for England are included the following stock for lines worked by electricity—viz., 96 locomotives, 642 carriages, and 19 other vehicles; and for Ireland the following stock for light railways—viz., 47 locomotives, 134 carriages, and other vehicles attached to passenger trains, 497 wagons, and 20 other vehicles.

IN Georgia the Courts have just dealt severe punishment to a negro who attempted to wreck a car of the Savannah Electric Company. It was shown that the negro had been put off the car because of disorderly conduct. On the return trip the car struck a board that had been nailed upright between the cross-ties of a trestle. Only the fact that the obstruction was of decayed wood and was easily battered down by the force of contact saved the car from being pitched from the trestle.

ONE of the highest speeds ever attained in America was on the Central Railroad of New Jersey on November 18th, 1892, when two miles near Fanwood, N.J., were passed over at the rate of 97·3 miles per hour, according to stop-watch measurement This speed was reached in the middle of a very long tangent, and where the engine was aided by a down grade for some distance, circumstances far more favourable to high speed than the conditions under which the New York Central's alleged speed record was made.

ALTHOUGH there is common complaint in the United States that railroads are not buying bridges or making other improvements that cost money, the Chicago and North-Western Railroad has recently made improvements, including sixty-two steel bridges on masonry and thirteen on pile supports, aggregating 3496ft. in length, and containing 2524 tons of steel. The department of maintenance of way of that road has also replaced wooden bridges, aggregating 11,246ft. in length, with masonry arches, box culverts, and cast iron pipe.

THE Bloomington, Pontiac, and Joliet Electric Railway Company is about to put into service two cars equipped with the new General Electric Company's single-phase, alternating-current motors. These are to be used on the 20 miles of line which this company expects to have completed by the end of the year between Pontiac, Ill., and Dwight. As it is not expected that the cars on this road will be required to operate over direct-current trolley lines, the series parallel method of control will not be used, potential control being used instead. A considerable saving over any other method of construction, it is said, has been made possible by the use of alternating-current motors on this particular road.

THE promoters of the new Sunderland-Darlington-Barrow railway are pushing their scheme forward in the district through which it will pass. At Darlington the Parliamentary and Commerce Committee of the Town Council had the matter under consideration, and general sympathy was expressed with the proposal, but it was decided to ask for more information for the consideration of the General Purposes Committee. At Sunderland the scheme has received the approval of most of the public bodies, but the River Wear Commissioners passed a resolution which rather "damns the scheme with faint praise." There seems to be an idea that business men in Sunderland are furthering the movement in order to get improved facilities out of the North-Eastern Railway Company.

NOTES AND MEMORANDA.

IT is officially announced by the Automobile Club de France to the Automobile Club of Great Britain and Ireland that the race for the Gordon Bennett Cup will take place between July 25th and August 8th next year.

THE rusting of hoops on wooden water tanks has been the cause of another accident, this time to the water tower of the Upper Sandusky Waterworks Company, thus illustrating the importance of keeping the hoops in good condition.

THE output of platinum in Russia in 1903 is reported at 5995 kilos., against 6126 kilos. in 1902, a decrease of 131 kilos. Only a trifling quantity was manufactured in Russia, the rest being exported as crude or refined metal—chiefly crude.

THE new harbour at Osaka, Japan, has now been opened for traffic. Although Osaka is the headquarters of the rice and tea trade, its harbour formerly was only sufficient to admit small craft. Large vessels were compelled to discharge at Kobe, the neighbouring port.

A TURBINE steamer is being built for use in passenger service between Chicago and South Haven. The new boat will be the first of this type to be built on the lakes, although second in the service, the Turbinia built in England now being engaged on the Hamilton-Toronto route.

LUCIANO BUTTI, an Italian inventor, has designed a photographic apparatus by means of which it is possible to record 2000 photographic impressions per second. This discovery will prove of inestimable value for the minute observation of insects and other creatures in rapid motion.

A DANISH scientist, C. F. Hilkier, has invented an automatic alarm which acts only when a sudden wave of heat or cold is generated in an enclosed space, and is not influenced by an evenly created high or low temperature such as that caused by intense summer heat or the severest frost in winter.

COLONEL DRISHENK has concluded a series of expeditions for the exploration of the sea route to the mouths of the Obi and Yenisei, and states that the voyage from Archangel can be accomplished in seven days in favourable weather, and that the voyage from St. Petersburg to the Yenisei estuary takes eighteen days.

IT is stated that an attempt made by the Indian Government to establish wireless telegraphic communication in Burmah between Diamond Island and Amherst, a distance of 212 miles, across the Irrawaddy Delta and the Gulf of Martaban, was not altogether successful owing to atmospheric disturbances.

IT is stated that the State University of Champaign, Ill., has ordered a 600,000 lb. testing machine of the vertical screw type made in such a way that columns, long testing pieces, beams, and large irregular shapes can be taken care of. It is said to be the largest vertical screw power testing machine ever built.

THE turbine-propelled steamer Loongana arrived at Fremantle 30½ days after clearing Glasgow. It was found that with four boilers at work the vessel could easily maintain a speed of 18 knots an hour in the roughest weather. The average speed was 15 knots, and it was attained on a daily consumption of 63 tons of coal.

IMPORTS of cement into the United States for the eight months ending August 31st were 121,337 short tons, against 348,069 tons in the corresponding period of 1903, showing a decrease of 226,732 tons, or 65·2 per cent. The principal items this year were 64,218 tons from Germany, 46,469 tons from Belgium, and 5267 tons from France.

A STEEL vessel, the interior of which is to be furnished in unique manner with the modern conveniences of a Pullman car, has just been ordered. The steamer will be used on Lake Michigan in the excursion trade between Escanaba, Gladstone, and Mackinac Island. The vessel will be 150ft. long, and will have accommodation for 700 passengers.

M. BORJA DE MOZOTA, Administrator of the Bureau Veritas—the French Lloyd's—has declared to the *Matin* naval correspondent that the Toulon-Algiers motor boat match is calculated to render great service to the mercantile marine, which still hesitated to adopt explosion motors, and his bureau had under consideration a project for classing these small craft.

THE Chicago Steel Manufacturing Company, New Castle, Ind., unable to secure enough boys to operate its nail machines, has filled the vacancies with girls, and reports much satisfaction with the character of work which the girls are doing. The company is turning out from 300 to 400 kegs of steel and iron cut nails per day, and about 2500 agricultural shapes daily.

THE number of French firms at present engaged in the manufacture of automobiles is 185, and in the manufacture of accessories 375. The value of the annual production of motor vehicles for the past three years is estimated as follows:—1901, 30,000,000f.; 1902, 60,000,000f.; 1903, 100,000,000f. The revenue accruing to allied industries during the same period is said to have been:—1901, 15,000,000f.; 1902, 30,000,000f.; 1903, 50,000,000f.

AN amended definition of the term Portland cement has been adopted by the Association of German Portland Cement Manufacturers. It is defined to be a hydraulic cementing material of specific gravity not less than 3·1 in the calcined state, and containing not less than 1·7 parts by weight of lime to each one part of silica + alumina + iron oxide, the material being prepared by mixing the ingredients intimately, calcining them to not less than clinkering temperature, and then reducing the whole to the fineness of flour.

THE annual report of the United States Geological Survey on the production of petroleum in the United States in 1903 states that the output reached the large total of 100,461,337 barrels, being larger than that of any previous year, and greater than that of 1902 by 11,694,421 barrels, or 13·17 per cent. The greatest part of the increase during 1903 was from the State of California, which produced in that year nearly one-fourth of the entire output. The total value of the oil produced in 1903 was £18,938,810, as compared with £14,235,780 in 1902.

THE experiments with submerged coal, which commenced at Portsmouth about eighteen months ago, have been resumed. In May, 1903, five crates of coal, each holding two tons, were sunk in No. 2 basin, and a similar quantity was placed at the coaling point in small heaps, covered with tarpaulins. Six months ago some of the submerged coal was raised and burnt, in conjunction with a similar quantity of that which had been kept on land, and the results showed that the submerged coal had greater calorific qualities. A similar test is to be made on the present occasion.

THE copper sulphate method of treating water infected with algæ is still being studied by the Massachusetts State Board of Health, says the *Engineering News*. One of the chief objects of the studies is to determine what becomes of the copper added to the water. In making the tests for copper in minute quantities, advantage has been taken of the experience gained and method perfected a few years ago when the board was studying the effect of various waters on lead, copper, and other water-service pipe. The results of the copper sulphate studies will not be published for some months, owing to the time required to bring them to an authoritative conclusion.

MISCELLANEA.

REUTER'S New York correspondent says that the reservoir supplying water to Winston and Salem, in North Carolina, burst on Tuesday. Seventeen persons lost their lives, and many are missing.

A FURTHER trial of a system of coaling at sea was last Tuesday carried out in the Solent by the Revenge, battleship, and the Basilisk, sloop. The speed of the vessels whilst under way was eight knots.

AFTER boring ten years with much perseverance and expenditure for coal at Point of Ayre, near Ramsey, the enterprise has been practically abandoned for the salt industry, which promises to be more profitable.

THE rainfall at Glencorse, one of the sources from which the Edinburgh and District Water Trust obtain a supply, was 31·51in. from January 1st to November 1st this year, as compared with 45·58in. and 23·43in. in the corresponding periods of 1903 and 1902 respectively.

THE number of vessels of all kinds launched on the Tyne during October was 10, of an estimated register tonnage of 14,146 tons. The total from January 1st was 109 vessels of 121,223 tons aggregate; 28 vessels of 38,949 tons were laid up, as against 33 of 50,165 tons in September.

THE manufacture of calcium carbide in the electric furnace needs a large amount of power. A year or so ago it was usual to reckon that a horse-power year was necessary to produce a ton of carbide. Now modern works succeed in turning out as much as 1½ tons for the same expenditure of power.

THE Canadian authorities are said to be much interested in the attitude of the Imperial Government towards the national control of wireless telegraphy. If Great Britain assumes the lead in the matter and takes over the direction of the instruments in the British Isles, it is thought that Canada will do the same in the Dominion.

THE largest steel-making firms in this country, in view of recent developments in connection with the formation of syndicates in the steel trade both at home and abroad, are contemplating combination for mutual protection. The object, says a correspondent, is to frustrate attempts by foreign manufacturers to invade the English market. The proposed combination is for offensive as well as defensive action.

AN International Gas Exhibition is to be opened at Earl's Court on the 19th inst., under the auspices of the Institution of Gas Engineers. More than 200 exhibitors from the United Kingdom, America, Germany, and other countries will take part. It is claimed by the promoters that the largest collection of appliances for the utilisation of gas for heating and lighting purposes ever brought together will be on view.

THE Egypt Exploration Fund will continue this season the excavations on the site of the Temple of Mentuhetep at Deir-el-Bahri, which have already yielded results of great historical importance. The excavations will again be conducted on behalf of the Fund by Mr. H. R. Hall, of the Department of Egyptian and Assyrian Antiquities of the British Museum, who is shortly leaving to commence operations at Dsir-el-Bahri.

AN open competitive examination for not fewer than twenty situations as assistant examiner in the Patent-office will be held by the Civil Service Commissioners in January next. The examination will commence on the second of the month and forms of application for admission to it are now ready for issue, and may be obtained on request addressed by letter to the Secretary, Civil Service Commission, Burlington-gardens, London, W.

ON Tuesday, the 8th inst., the new Imperial dock at Leith harbour was formally opened. The new dock is 1900ft. by 500ft., and 40ft. deep, and gives a surface of nearly 20 acres. Hitherto the trade of the port has been much handicapped by the inability of any of the existing docks to take in vessels of more than 4000 tons. Vessels of greater tonnage had in consequence to lie in the Forth roads until high water, but with the opening of the Imperial dock, vessels of 6000 tons will be able to dock upon their arrival.

SIR WILLIAM GARSTIN, at present Under-Secretary of State for Public Works in Egypt, has been appointed adviser to the Khedive in affairs relating to public works. The Council of Ministers will recommend the Khedive to order the raising of the Assouan barrage, and, secondly, to authorise the opening of a credit of £E1,136,000 for the construction of a barrage similar to that of Assiout to be situated at Esneh, between Assiout and Assouan. This latter enterprise will probably be thrown open to competition among several selected firms.

WHEN, as a practical result of the *entente cordiale*, France was asked to join in the Greater Britain penny post, M. Delcassé replied that this was impossible so long as the French inland letter rate remained 15c. = 1½d. per 15 gr. = ½ oz.; but, twenty-five years ago, when this rate was reduced from 25c. to 15c., a further reduction to 10c. = 1d. was promised so soon as the state of finances permitted, and the Post-office receipts had increased in the interval from 122 to 228 million francs, or from £4,880,000 to £9,120,000. In France there is only one post-office for every 3718 inhabitants, and an agitation is on foot for much-needed postal reform.

THE work of laying a submerged main, at a depth of 83ft., across the channel in Cork Harbour, which separates Queenstown from Haulbowline, has been completed. It is for the purpose of giving an ample supply of pure water to the dockyard of Haulbowline. When the engineers first designed the work it was thought by many experts to be impracticable owing to the great depth of water in the channel, and because of the exceedingly irregular nature of the bottom, which chiefly consisted of hard, jagged limestone rocks. The submerged main is about 2000ft. in length, and consists of specially cast 6in. internal diameter ball-and-socket jointed pipes.

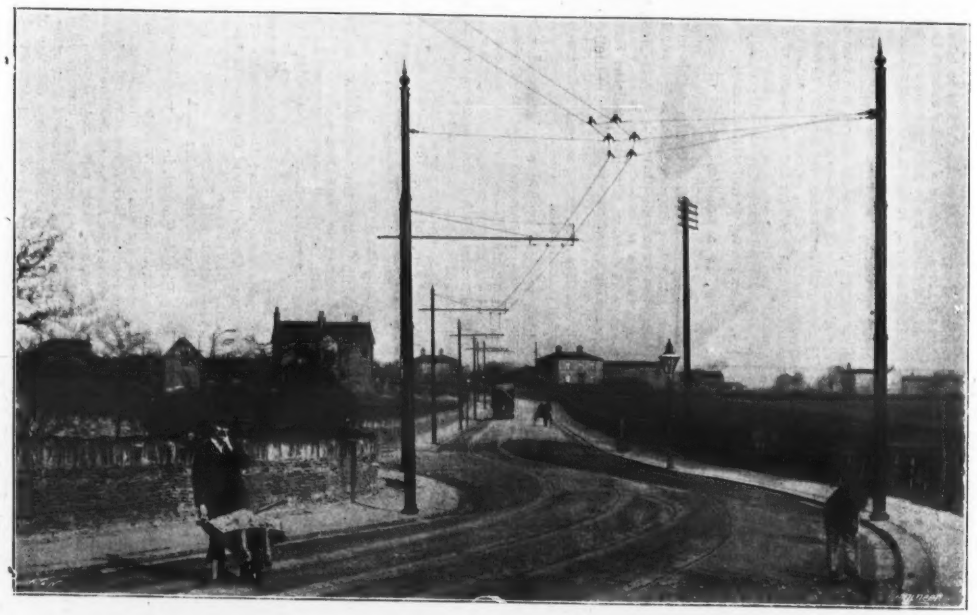
AT a time when the shipbuilding industry is very quiet it is interesting to know that a Brazilian Commission is in this country with the object of placing orders for the Brazilian navy. These orders will include three battleships of the Triumph type, of 13,000 tons each; three armoured cruisers of the Bayan type, 9500 tons; six destroyers of 400 tons; six torpedo boats, 130 tons; six torpedo boats, 50 tons; three submarines; and one transport, 6000 tons. The majority of these orders will be placed in Great Britain. The guns are to be of Armstrong's model, the armour of Vicker's patent, with Belleville boilers for the large vessels, and Yarrow boilers for the smaller craft.

THE British Consul, in his yearly report, draws attention to the bicycle trade of Japan. He states that at first the bicycle was, for some reason unexplained, not taken kindly to. But this condition is changing now, and many believe it has a great future before it in Japan. In 1902 the number of bicycles imported was 11,782, and their value 232,132 dols., while in 1903, though the number was somewhat less, namely, 10,978, their value was 239,171 dols. This coincidence of a decrease in number with a rise in valuation is attributed to a decrease of imports from the United States, and a growing appreciation of the higher-priced, more solid and valuable bicycles from Great Britain. In fact, those coming from the latter country increased in the year from 197, worth 5714 dols., to 730, worth 21,930 dols, while from the United States the falling off was noteworthy.

WAKEFIELD AND DISTRICT LIGHT RAILWAYS

DICK, KERR AND CO., LIMITED, LONDON, ENGINEERS

(*For description see page 476*)



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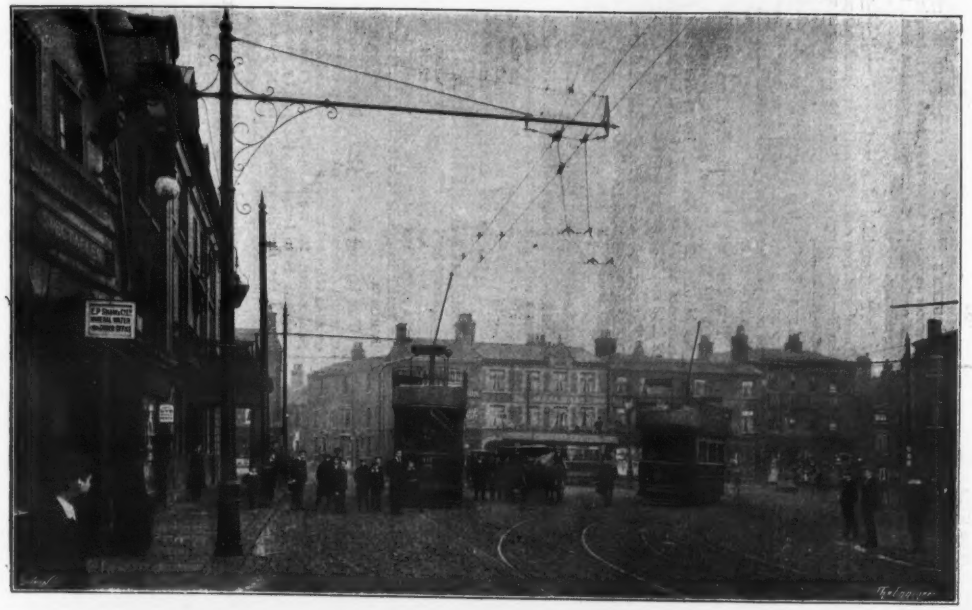
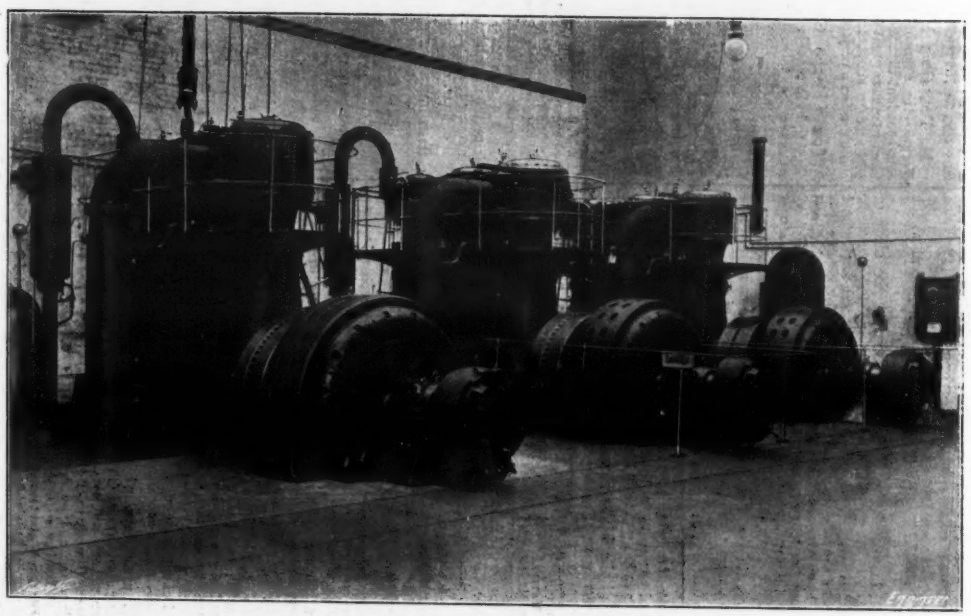
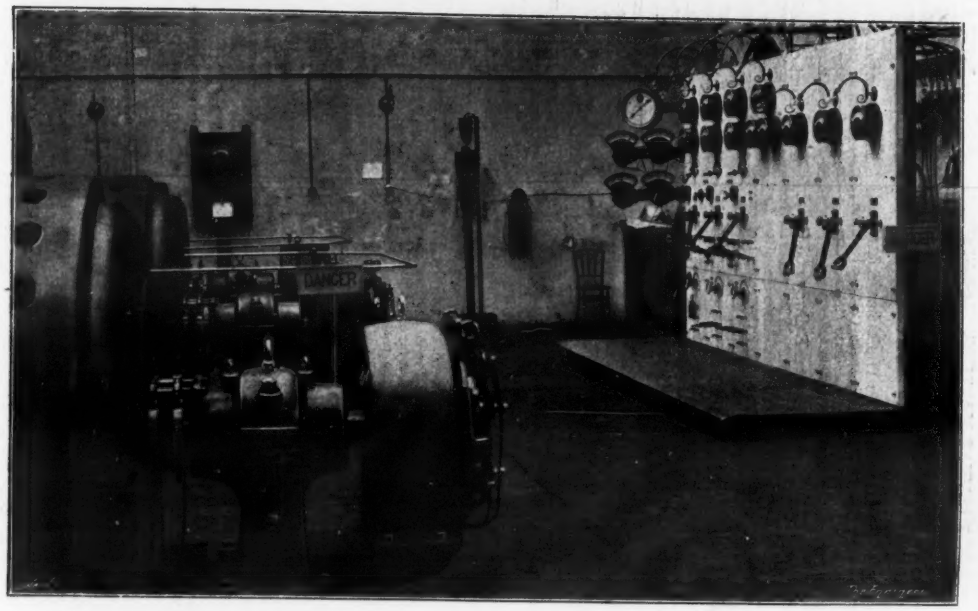


BULL RING, WAKEFIELD



ENGINE HOUSE



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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Ten o'clock on Tuesday morning in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of The Engineer.

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* The Engineer, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

T. R. (Rue Cimarosa).—The book you mention has not come under our notice.

J. Y. (Aberdeen).—There is no such thing as conformity of practice in the proportions of air pumps. Watt made his one-eighth of the capacity of the cylinder. In modern practice they are much smaller. Seaton gives $\frac{23}{}$ capacity of low-pressure cylinder as the rule for ordinary merchant steamers. The pump is single-acting.

Flex (Nottingham).—In this country stay bolts are often drilled through to give flexibility, and to show by leakage when a crack occurs. In the United States there is a rolled hollow stay, really an extremely thick tube, made by the Falls Hollow Stay Bolt Company, of Cuyahoga, Ohio. These bars run to lengths of 8ft. or 10ft., and appear to be much favoured on the other side of the Atlantic. We can give you no information about price.

INQUIRIES.

MUFFLER POP VALVES.

Sir,—I should be much obliged if any of your readers could inform me where I can obtain Richardson's Muffler Pop Valves. L. C.
November 9th.

TRIAL BORINGS.

Sir,—I would be obliged to any of your readers who can tell me of any treatise describing the method of making trial borings.
Waterford, November 2nd. Foundations.

HIRE OF WATER POWER.

Sir,—Could any of your readers kindly inform me what approximately is the annual value for letting the use of a 20 horse-power water turbine of the very latest American pattern, with governors, situated in suitable buildings about a mile from a station, which is about 55 miles from London? C. T.
Petworth, Sussex, November 4th.

MEETINGS NEXT WEEK.

The Royal Scottish Society of Arts.—Monday, November 14th, at 8 p.m., at 117, George-street. Annual general meeting. Opening Address by the President.

Institute of Marine Engineers.—Monday, November 14th, at 8 p.m., at 58, Romford-road, Stratford, E. Discussion on "Technical Education." Paper by the Hon. Secretary.

Society of Arts.—Wednesday, November 16th, at 8 p.m. Inaugural Address by Sir William Abney, K.C.B., D.C.L., D.Sc., F.R.S., Vice-president and Chairman of the Council.

The Institution of Mechanical Engineers: Graduates' Association.—Monday, November 14th, at 8 p.m. Paper, "New Electrical Swing Bridge over Flood-course of the River Weaver, Northwich," by Mr. T. P. B. Cliff.

Liverpool Engineering Society.—Wednesday, November 16th, at 8 p.m., at the Royal Institution, Colquitt-street. Ordinary meeting. Paper, "Some Engineering Problems in a Gasworks," by Mr. Edward Allen, M.I. Gas E.

Bradford Engineering Society.—Wednesday, November 16th, at 7.30 p.m., at the Bradford Municipal Technical College, Great Horton-road. Paper, "Commercial Aspects of Power Plants in Factories," by Mr. Herbert W. Morley, M. Inst. Mech. E.

The Junior Institution of Engineers.—Friday, November 18th, at 8 p.m., at the Westminster Palace Hotel. Presidential Address on "Municipal Engineering on the Continent," by Mr. William H. Lindley, M. Inst. C.E., F.G.S., of Frankfort-on-Maine.

Institution of Electrical Engineers: Leeds Local Section.—Thursday, November 17th, at 7.15 p.m., at the University, Leeds. President's Inaugural Address, followed by paper on "Large Gas Engines for Central Stations," by Mr. H. Campbell, M.I.M.E.

The Institution of Mechanical Engineers.—Friday, November 18th, at 8 p.m., at the Institution House, Storey's-gate, St. James's Park. Paper, "Impact Tests on the Wrought Steels of Commerce," by Mr. A. E. Seaton, of London, and Mr. A. Jude, of Birmingham.

The Institution of Civil Engineers.—Tuesday, November 15th, at 8 p.m. Papers: "Coast Erosion," by Alfred Edward Carey, M. Inst. C.E. "Erosion on the Holderness Coast of Yorkshire," by Ernest Romney Matthews. "Distribution of Electrical Energy," by John Francis Cleverton Snell, M. Inst. C.E.

Royal Meteorological Society.—Wednesday, November 16th, at 7.30 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Ordinary meeting. Papers: "Meteorological Observing in the Antarctic," by Lieut. Charles Royds, R.N. "Decrease of Fog in London during Recent Years," by Frederick J. Brodie, F.R. Met. Soc. "Hurricane in Fiji, January 21st-22nd, 1904," by R. L. Holmes, F.R. Met. Soc.

DEATH.

On the 8th November, 1904, at Brussels, Frank McClean, M.A., LL.D., F.R.S., F.R.A.S., M.I.C.E., J.P., of Rusthall House, Tunbridge Wells, and 1, Onslow-gardens, S.W., only son of the late J. R. McClean, F.R.S., M.P., one time President of the Institution of Civil Engineers, in his 67th year. The funeral takes place to-day, Friday.

THE ENGINEER.

NOVEMBER 11, 1904.

THE STEAM TRIALS OF MODERN WARSHIPS.

The ordinary conditions which have hitherto been laid down by the Admiralty for the conduct of the trials of their battleships and cruisers before acceptance from the hands of the builders will doubtless be familiar to most of our readers interested in naval matters. As the Admiralty have, however, recently issued additional instructions for the carrying out of future steam trials which involve changes of procedure of a very important nature, we think it will be of interest to our readers generally, and more especially to naval officers and to those engaged in the construction of warship machinery, if we briefly consider the bearing which these regulations have on the design and construction of the machinery, both from the point of view of the contractor who has to make it and carry out the trials, and of the naval engineer, to whose care it is afterwards committed.

The following are the new regulations:—(1) No water is to be used on the bearings during the official steam trials. (2) Oil is to be supplied to the bearings through the medium of the usual service oil fittings only. (3) Clearances between bearing surfaces are not to exceed certain specified limits. (4) The number of persons employed in looking after and attending to engines and boilers is not to exceed a certain specified number. This number is exclusive of firemen and trimmers, actually employed in putting coal on the fires. (5) All hatches, doors, and valves, automatic or otherwise, below the armoured deck are to be closed by hand as soon as the anchor is off the ground, and not opened until the anchor is let go again, except in the following cases:—(*a*) For purposes of ventilation for half an hour in the day, or for so long as is considered absolutely necessary by the captain. (*b*) In parts of the ship which it is absolutely necessary to keep constantly ventilated, such as where men are employed or sleeping. In cases (*a*) and (*b*) men should be specially stationed to close by hand if required all openings which are by necessity left open. (6) The doors between the engine-rooms and stokeholds are to be kept closed. (7) All bunker doors are to be closed with the exception of such bunker doors in each stokehold as the coal is being worked from, and one door between each two bunkers, it being of the greatest importance to keep these doors closed as much as possible. These regulations, we may add, are applicable to all official trials, but will not be enforced on builder's preliminary trials.

Let us now consider first the policy which dictates the laying down of these new and onerous conditions. These regulations are simply designed on the basis of the conditions which would exist on the ship's going into action. No one, we think, can question the wisdom and sound common sense of insisting that warship trials shall be conducted under such conditions as shall ensure their general fitness and reliability under the most trying conditions to which they may be subjected as fighting machines. We think that machinery contractors themselves will be the first to admit the sound business principles on which this policy is based, however much it may add to their cares and responsibilities in the running of new and high-powered machinery. It will also, we believe, be welcomed by naval engineer officers who have in the past been called upon to reproduce in service results attained on contractors' trials, which were run under conditions of *matériel* and *personnel* very different from what obtains on a commissioned ship.

Coming now to the regulations in detail as they affect the construction of warship machinery, we may say at once that there is nothing in any one of them which good engineering, care, and money cannot meet. Conditions (1) and (2) simply call for the most careful consideration of the proportions of the bearing surfaces, and the adequate and trustworthy supply of lubricant through permanent fittings. The conditions are designed to prevent the lavish and wasteful pouring on of oil, which has hitherto been often seen in trials, to an extent which would be quite inadmissible on a ship on service, keeping the sea with only limited storage for oil. The third condition fixes limits for the clearances of bearing surfaces which are quite within the bounds of existing first-class practice.

We shall consider conditions (4) and (6) together, regarding the restricted complement of men to be employed in attendance on the machinery, and the closing of doors between engine-rooms and boiler-rooms, as these two requirements are those which touch the contractor most closely, and which will have to be met by very much the same procedure and organisation in future trials. The number of men laid down as admissible by the Admiralty is very much less than what has been customary on trials in the past. It has been based on the available complement when the ship is in commission. The much larger number usual on contractors' trials is, of course, accounted for by the fact that they are running new and untried machinery, with the possibility of latent defects developing at many points simultaneously, which would demand instant attention if the trial were to be continued to a successful conclusion. The very object of the trial has been to demonstrate these weak points and remedy them, and consequently the machinery, when turned over to the fleet, has been in a condition permitting of much less attendance than when it came new from the shops. A restricted complement on official trials, therefore, means that all these minor defects must have been eliminated beforehand, and this will only be posible by greater care in design, construction, and erection on board, and by the running of more preliminary trials by the contractors before reporting the ship ready for the official tests.

Condition (6), insisting on the closing of the

doors between the two engine-rooms and between the engine-rooms and the stokeholds, is perhaps the most serious of all from the contractor's point of view, as it absolutely restricts within narrow limits the supervision and direction of affairs by the responsible manager in charge of the trials. In the past the heavy water-tight doors giving communication between these various compartments have stood open, and only light-hinged screen doors, readily opened, have separated the different points at which the manager's attention might require to be concentrated at any time. In the future, should trouble arise in either engine-room or in any of the stokeholds, he will have to go on deck and descend again into the compartment where he is needed, through the scuttles in the armoured deck, a somewhat lengthy course. This condition also, then, can only be met by a greater degree of perfection being attained in the machinery before official trials are entered upon, by greater care and additional preliminary runs, and possibly by the posting in the various compartments of more responsible men, capable of taking the initiative in emergencies, than have been considered necessary in the past.

Condition (5) calling for all hatches, doors, &c., to be closed below the armoured deck is important, as far as trials are concerned, mainly in so far as it affects the ventilation of the engine-rooms. Under these circumstances fresh air in the engine-rooms will be absolutely dependent on the artificial supply from the fans, and the new conditions will try the adequate efficiency of this important part of the installation very much more highly than has been customary. A recent newspaper report on the trials of a war vessel run under these new conditions stated that the temperature on the platforms at the lower levels was from 90 deg. to 100 deg. Fah., and added that this might be regarded as not abnormal. We think, however, that such a temperature, while endurable when running on the Clyde or in the North Sea, would be absolutely intolerable in the tropics, and in our ships the latter conditions have to be encountered. This new condition, therefore, will probably entail more careful consideration of the fan power to be installed in the engine-rooms of future ships. As regards condition No. (7), relating to the closing of bunker doors, we do not think that this will add to trial trip difficulties when the stoking and trimming arrangements are well organised.

It will be seen, therefore, that while these new regulations do offer considerable difficulties in accomplishment, they may be met by foresight and care, and that they afford a good guarantee that, being accomplished, our ships will be placed in the hands of the naval officer in such a condition as to be efficient for the most arduous and trying circumstances which he may be called upon to meet.

MUNICIPAL EXPENDITURE.

It is well known that for some time past one municipality after another has been borrowing from banks, generally by way of overdraft. There is reason to believe that the banks are becoming alarmed, uncertain, dubious. It is easy to learn something of the drift of financial opinion in this respect from the speech delivered last week by the chairman of Lloyd's Bank before the Institute of Bankers. The municipalities of the kingdom great and small, have swamped the market with bonds and paper securities of all kinds. The general public has responded to the demand, and enormous expenditure has been encouraged. At last investors have begun to understand that municipal securities are no longer "gilt-edged." The "market is flooded with Corporation stock." Investors have raised the price of loans, and the County Councils have been compelled to obtain money by overdrafts from the banks at high interest. High as it is, there is a prospect that it will become still higher, and in this way it is hoped that the automatic action of the money market may check an extravagance which is passing all bounds. The sooner those who have money to lend fully understand the financial position the better. According to the showing of the Local Government Board, outstanding local loans had risen from £92,820,000 in 1874-5 to the enormous sum of £343,416,000 in 1901-2. The returns for 1893-4 are not yet obtainable, but they will certainly not be more favourable than those given above. The indebtedness of London amounts at this moment to £100,432,000, or two and a-half times the rateable value.

The entire subject of municipal enterprise is full of complications; but it is possible by narrowing the range for consideration to arrive at certain broad statements of fact, which are very important, and not at all confused or confusing. One of the first of these is that municipal enterprises may be divided under three principal heads. We have, in the first place, works which are necessary, and must be carried out, whether they will pay or not; principal among these is sewerage. Next, we have work which is more or less speculative, such as tramways and gas. Lastly, we have work which will certainly not pay, and is intended for the beautifying of a town and the glorification of individuals. We may cite as an example the palatial municipal buildings of Glasgow, said by many of the citizens to represent great waste of money. It is not very easy to arrive with precision at the various amounts spent in this way; but, roughly, it may be taken that waterworks, gasworks, and sewerage have required an expenditure of £114,000,000, while "other works and purposes" represent an outlay of about £81,000,000. Let it be assumed—and it is a great assumption—that all the enterprises undertaken by municipalities have been necessary. Then comes the question whether they have been carried out on the best available lines by the County Councils. So far as we are aware, there is a consensus of opinion in the negative so far as those who have not seats at the Council tables are concerned, and by a considerable minority of those who have. It would be mere waste of time, however, to go over again well-trodden ground and reproduce in our columns that which we have already on various occasions written in the way of comment and criticism. But the financial world has not stood still, and those who may be regarded as authorities on all money matters do not hesitate to assert that municipal extravagance in the past has had much to do with trade depression in the present, and our principal purpose in writing now is not to find fault with municipalities, but to consider what the effect of their policy has been on the trade of the country. Very large sums of money, representing part of the national savings, are held by what is known as "the public" for want of a better title. We are not now writing about millionaires, but about those who have a few thousands or a few hundreds to invest, and who desire to get the best return they can for their money. It is sound finance to maintain that money should not be spent in unremunerative undertakings. Now the municipalities have raised loan after loan with great facility. Much of the money thus obtained has been spent, as we have said, in carrying out work essential to the health and prosperity of a growing city. The taxpayers have no right to complain in a general way of this outlay, although they may criticise the methods of expenditure. But when we come to undertakings which are not necessary, and are in the main usually speculative, the conditions are entirely different. Let us keep in mind the man with two or three hundred pounds to invest. The council of Blexam-on-the-Marsh hold that £30,000 ought to be spent on a system of tramways. It would be vain to approach the public with a scheme for the promotion of a limited company to make the tramway. The public would not consider the security satisfactory. But the public will lend the money three times over on the security of the rates—that is to say, of the ratepayers. It is clear that in this case the County Council is much more audacious than the general public, for they will plunge into a speculation which the outsider will not touch. The reason is that the Council are not speculating with their own, but with other people's money. The result is the placing on the market of what we may term a forced security. To make the real meaning of the whole transaction plain, let it be supposed that A. is told by B. that it is desirable that a lamp should be put up in A.'s street, that he has borrowed money in A.'s name to pay for it, and that A. must pay the interest. We all know what would be the result in private life; but in municipal life we have a different set of conditions. Thus the Council in Marylebone threw a tremendous load of debt on the shoulders of the unfortunate ratepayers, not only without their consent, but under vigorous protest. We have, then, much finance which is quite unsound, yet has had the effect of diverting the available capital of the country into non-remunerative channels. Enormous sums have been spent in this way, and frittered out, for the most part, in such a fashion that it may be regarded as lost capital. The argument may be put in another form by saying that municipalities have outbid private enterprise in paying for money. It is to municipalities that manufacturers have had to go for a market, and yet those who give the orders have absorbed all the capital which the manufacturer requires in the carrying on of his business. Our readers may accept our word for it that this is the view taken by some of the most competent financiers of the day.

The answer of the municipalities is, of course, that they have conferred great benefit on the towns whose credit they have pledged, and that they have found work and wages for many deserving people. We must ask our readers to keep their minds clear of all arguments of this kind, which, whether true or false, sound or unsound, have nothing whatever to do with the facts which we desire to impress on their minds. We repeat them. Trade is indifferent or bad; various causes contribute to this end. One of the most potent is the enormous indebtedness of the municipalities. Rates and taxes have become a heavy burthen, telling against the prosperity of the towns implicated. But the principal point for consideration is that the available wealth of the country has been invested in what are very largely non-remunerative undertakings. The ready money, the loose cash of the community, has been swallowed up in providing people's parks, magnificent town halls, tramways, and electric lighting schemes that do not pay, and so on. Let it be granted for the sake of argument that the money has been spent to the best advantage. None the less it appears to have been an expenditure which the country could not afford; and the more fully all the facts are considered the more certain is it, we think, that the views held by the authorities to whom we have referred are sound, and go far to explain the present state of trade in some of its aspects. Towns can no more get into debt with impunity than can individuals; and it is an alarming fact that on the showing of one eminent banker the municipal indebtedness of the nation equals £10 11s. 3d. for every head of the population, and this indebtedness, instead of being diminished, is being daily augmented. Local authorities, we are told, have now to pay so much for loans that £100,000 borrowed now, to be paid off in sixty years, means a total expenditure to the ratepayers of double that sum. When we find a town like Ilford overdrawing its banking account by £30,000, we naturally ask what will be the upshot of finance which finds its only accurate parallel in that of Mr. Micawber.

STEAM TURBINES.

Recently the pages of the technical Press have been flooded with articles about steam turbines. Many books have been written in English, French, German, and Italian concerning their theory, functions, and construction. It is estimated that over four hundred patents have been taken out for improvements in steam and gas turbines within the last score of years; and with all this, to judge by the letters which we continue to receive from correspondents in search of information, widespread confusion of ideas and even positive ignorance continue to exist among men practically engaged day after day in the construction of steam machinery. No doubt much of this lack of knowledge is due to the way in which the subject has been handled. The steam turbine is in one sense very simple, and its theory can readily be made intelligible; but it courts mathematical treatment, and admits of definitions which are not easy to follow by those who have not mental facility for thinking in a special way. Examples of obscurity are quite easily obtained. Take, for instance, the following passage from a paper recently read in the United States:—"In all cases the transformation from heat energy into what may be called jet energy is effected by allowing the steam to expand against a pressure lower than its own, and thus to develop the velocity of jet by what may be termed a rectification of the orbital velocity of the molecule, and its direction along the line of least resistance." No doubt the author understood what he wanted to convey, but we do not hesitate to confess that we have failed to grasp his meaning. We believe, however, that it is quite possible to make the principles on which the steam turbine works clear without having any recourse to recondite phraseology or mathematics outside simple arithmetic.

We take the Laval turbine as the simplest type of the machine. In it steam, as is well known, is allowed to blow against vanes on the rim of a wheel. These vanes are cupped in order that the steam recoiling from the wheel may return, so to speak, on itself. Very little thought is required to show that if the curve of the cup is of the proper shape, and the tangential velocity of the cup—that is to say, the speed with which it moves away from the jet—is half that of the jet, the steam will leave it without any velocity whatever, and the whole of the energy in the jet will have been transferred to the wheel. Now, at this point the circumstance that steam is an elastic fluid comes in to cause mental confusion. It is hard to credit the statement that an elastic fluid can really leave anything with which it has been in contact without velocity. The fact which our readers must get into their heads is that in the Laval turbine the working steam is not an elastic fluid, and has no pressure.

To make this clear, let us suppose a Laval wheel of 100 horse-power using 20 lb. of steam per horse per hour, that is to say, 2000 lb.; and per minute, leaving out fractions which we do not want, 33 lb.; and per second a little over half a pound of steam. Now, the steam issuing from the boiler has a pressure of, say, 150 lb., but it is permitted to escape through a diverging nozzle, and the pressure is all expended in imparting velocity to the steam. Let us divest ourselves of all ordinary concepts about steam, and fancy that it ceases to be a fluid exerting pressure and becomes a torrent of very fine shot projected at a velocity of about 5000ft. per second, or nearly twice that of a rifle bullet, against the vanes of the turbine. We have no longer an elastic fluid to deal with; we have half-a-pound of something which may be regarded as solid—at least, in the sense that the water in a Pelton wheel is solid—moving at the enormous velocity we have stated. The work done by the steam entering the nozzle is entirely expended in pushing the molecules away in front of it through the nozzle and out at the other end. Each group of molecules, in a sense, acts the part of the charge of powder in a rifle to make those in front of it fly faster. To put the facts in another way, the result is just the same as though a stream of fine sand fell into a steam jet. The jet would impart its energy to the sand, and if the sand were directed into the vanes of a Laval turbine it would cause its rotation. Instead of sand we utilise the molecules of the steam. With these facts before us, we see why the velocity of the rotating wheel of the Laval turbine must be so high. It has to attain a speed of about 2500ft. per second, or over 1700 miles an hour, in order that the whole of the energy may be transferred to the wheel. It will be understood that, as far as the wheel is concerned, the steam has ceased to be an elastic fluid. It may be considered in the light of a shower of fine projectiles impinging on the vanes at an enormous velocity. Hence the revolutions of even as much as 30,000 per minute, in the smaller turbine.

The same effect takes place in the Parsons type of turbine, but the action is masked by the absence of the diverging nozzle. Divergence takes place inside the wheel casing, the steam expanding from step to step downwards. Quoting from Mr. W. F. Durand, an American engineer, we may say that, in turbines of the Parsons type, "the steam rushes from the steam supply to the condenser through the annular space between the wall of a long cylindrical casing and the contained rotor, increasing the cross-sectional area from the entering to the delivery end. This annular space thus constitutes in effect a gigantic nozzle within which the steam is continually undergoing transformation as it passes from one end to the other;" that is to say, it ceases by degrees to be an elastic fluid and becomes instead a furious torrent of molecules.

It is not necessary here to refer in any detail to the precise way in which the flying molecules of steam transfer their motion to the vanes. All that has been very fully set forth in our pages by Professor Smith. We happen to know that the major difficulty met with by those who want to understand the steam turbine is how a free elastic fluid can transfer its energy to a rotating wheel. The only way out of the difficulty is to say that the steam is not an elastic fluid, but a current of flying molecules—none the less molecules capable of mechanical action because they are small almost past the possibility of conception.

The initial perplexity in thinking about the steam turbine lies no doubt in clearly seeing how pressure—potential energy, to use what is little better than scientific jargon—can disappear and turn up in another form as kinetic energy. But when we dive a little below the surface it will be seen that, according to received theory, pressure itself is nothing more than the result of the impact of flying molecules—in fact, the whole energy stored in any volume of steam or other gas is always essentially kinetic. To pursue this branch of the subject would, however, lead us away from the purpose which we have had in view in writing this article. Many more patents will no doubt be taken out, but in so far as these refer to principle, and not to detail, the inventor will do well to keep the facts constantly in mind. The steam must be worked in such a way that while its molecules will always tend to move in right lines, they will give up their energy in the form of centrifugal effort, or recoil, according to the type of turbine in which they act. The ruling principle is always that we have a molecule, or a pound, or a ton, of steam, moving like a bullet at a velocity of 5000ft. per second, and we want to take all that motion out of it, transferring it to the rotating wheel. It is not, perhaps, easy at first to master the idea that steam can ever cease to be an elastic fluid exerting pressure in all directions; but once the facts are grasped, the whole theory of the action of the steam turbine becomes quite lucid and intelligible.

ENGINEERING PROGRESS.

One of the most satisfactory features of the present year has been the manner in which the foreign demand for British engineering productions has been maintained, and, indeed, improved upon. The combined exports of steam engines and machinery for the first ten months have amounted to the substantial sum of £17,352,142, or an increase of £817,620 upon the corresponding period of last year. This is an improvement of nearly 5 per cent. (4·94 per cent.), which, considering the severe foreign competition which has been experienced in the leading colonial and other markets from our European and American competitors, cannot be considered as other than encouraging. It is not a large increase in itself, but it has been achieved in face of considerable difficulties of a territorial and political character, and, moreover, it has to be borne in mind that these figures represent values. Now, the present year so far has been a period during which values in the engineering trades have been at a low level, with a tendency rather in a downward than an upward direction. For the export trade to show, therefore, an advance in aggregate value as compared with last year means more than at first sight appears, and argues a more than corresponding improvement in volume. In other words, the onward movement in the quantity of the engineering exports, and therefore in the extent of the occupation afforded to British engineering establishments, so far this year compared with last, has probably been much greater than 5 per cent. There is, however, no means of judging accurately the headway made in quantity. Out of this total value of over seventeen millions sterling steam engines account for somewhat less than one quarter, and other machinery for more than three-quarters. And whilst the lesser portion—*i.e.*, engines—of the aggregate shows a slight decline—the £4,231,949 worth of steam engine exports being below last year by 3·34 per cent.—yet the larger portion (*i.e.*, machinery) of the aggregate shows the substantial improvement of nearly 8 per cent., or, to be exact, 7·83 per cent.; for the general machinery exports, amounting to £12,714,419, are better than last year by £923,443. The exports of electrical machinery have gone forward from £370,281 to £405,774. British textile machinists have done much better this year than last with India, Germany, South America, and Japan, and it may be interesting, in view of the war, to notice that the headway made with the last-mentioned country has been from £67,642 to £96,743, which is an increase of £29,101, or 43 per cent.; whilst shipments to Russia, on the other hand, have declined from £337,909 to £254,228. The increase in the Indian demand was more than 31 per cent., namely, from £656,402 to £862,813; and in the German demand there has been an improvement of as much as 55 per cent., namely, from £503,171 to £780,224. Taking the trade with all countries into account, British textile engineers have done a business during the ten months with oversea markets worth considerably over four millions sterling. The advance in agricultural machinery, thanks chiefly to South America, Australia, and New Zealand, has been from £829,636 to £902,308, or a growth of £72,662. Sewing machinery has gone forward from £1,649,543 to £1,872,998, this being due mainly to an increased demand from the various European countries with whom the bulk of the aggregate trade has, as usual, been conducted. We are glad to be able to record an increase of £95,242, or 15 per cent., in the exports of mining machinery to all countries, these having amounted to £715,842, South Africa having improved from £293,550 to £300,314, and India from £59,711 to £93,974. With regard to other descriptions of machinery than those already specified, the value of the exports to all countries has reached the handsome total of more than five millions sterling—£5,084,316—which is better than a year ago by £240,571, or nearly 5 per cent—4·94 per cent.—the chief markets showing increases being India, South America and the United States. The whole of the foregoing figures relate to the first ten months of the present year compared with the corresponding period of last year. Engineers have, therefore, done very well, so far as their foreign business is concerned, during the chief part of 1904; and as there are only a few more weeks to run, it is reasonable to anticipate, supposing no material drawbacks to occur, that the complete year 1904 will prove, as regards export business in British engineering productions, a better period than 1903.

THE EIGHT HOURS DAY.

A novel view of the eight hours day is being taken in legal circles in the United States, which is of special and peculiar interest to municipalities and ratepayers. In this country the action of the London County Council and similar bodies elsewhere in fixing the rate of wages to be paid by contractors has been severely censured. No action has, however, been taken by the Councils in the way of fixing the duration of the working day. That is a length to which municipal audacity would not go. But in the United States there is more audacity or more political influence at the Council Boards, and attempts have been made to compel contractors to work on an eight hours day basis. Action has, however, been taken, in one instance at least, with success. A suit was brought in the Circuit Court at Milwaukee by T. J. Neacy and Walter Read, of the Filer and Stowell Company, against the city of Milwaukee and the William Tod Company, Youngstown, Ohio, to restrain them from carrying out a contract for a 20,000,000-gallon pump, which contained the objectionable eight-hour day clause. In this case organised labour took great interest, and two of its representatives were permitted to interplead as defendants, they making the claim that the city attorney had expressed himself frequently as believing that such a clause was contrary to law, and that, because of his personal bias, he could not successfully defend the action. Here we have two competing firms dealing with a question of general interest. The defendants had evidently got the contract because they accepted the eight hours day clause. The decision of Judge Halsey shows shrewd sense. It goes straight to the root of the whole matter. Any contract limiting the duration of the working day is declared to be illegal, because such a clause "lessened and restricted the number of bids, and thereby increased the price by many thousands of dollars, and is in direct violation of a section of the city charter, which requires that 'all contracts shall be let to the lowest bidder.' It is stated that the case will be carried to the State Supreme Court by the Federated Trades Council, and in the meantime Milwaukee chafes at the delay in securing additional pumping facilities for its North Point waterworks.

LAKE STEAMSHIPS.

We in this country take little interest in the development of the lake steamer, for the simple reason that we have no lakes worth speaking of. In the United States, however, the conditions are different. Their little inland seas supplement to a large extent the work of the railways as carriers. Development has gone on during the last few years at a tremendous pace, and the facts are valuable as denoting the manufacturing progress of the country. We quote from the *Marine Review*:—"It seems incredible, and yet the figures prove it to be true, that the average cargo carried on the great lakes ten years ago was 2500 tons, and that the largest cargo carried on the lakes as late as ten years ago was 3355 tons. The average cargo of the vessels under construction to-day is 9000 tons, and the Steel Corporation, the largest shipper and shipowner on the great lakes, has let contracts for four vessels of 10,000 tons capacity as the forerunners in the modernising of its great fleet. It is going to dispose of its smaller vessels, probably to scrap them if it cannot sell them." In 1856 the largest cargo of ore carried on the great lakes was 400 tons; five years later, in 1861, it was 460 tons; in 1866, 697 tons; in 1871, 1148 tons; in 1876, 1360 tons; in 1881, 1484 tons. We believe that the latest addition to the lake fleet will carry 10,300 American tons. This rush for big ships seems to be overdone. It has been calculated that there are sufficient vessels on the lakes now to deal with 40,000,000 of tons of ore per year, but facilities do not exist on shore for loading, unloading, or distributing it. The only approach to a parallel to this traffic is supplied by the enormous barges towed on the Rhine, and carrying cargo to the steel works in the neighbourhood of Dusseldorf.

DOCKYARD NOTES.

The Prince of Wales, it is understood, is going to sea early next year for an eighteen months' cruise. He will hoist his flag as admiral of the cruiser squadron on board the Roxburgh. The Roxburgh is one of the improved Counties, known as the Devonshire class.

Three of the latest submarines were to have attempted a cross-Channel passage from Dover, but bad weather necessitated their return.

The new "King Edward" dry dock at Gibraltar is now in a condition to be used. It is able to accommodate the largest warship existing or likely to exist for some time to come.

The King Edward VII. is doing her gun trials. An interesting "gunnery" feature of this ship is the special hooded position on the main mast for the range-finder or the "spotter."

The coaling-at-sea invention of Engineer Commander Metcalfe is being tried with H.M.S. Revenge at Spithead.

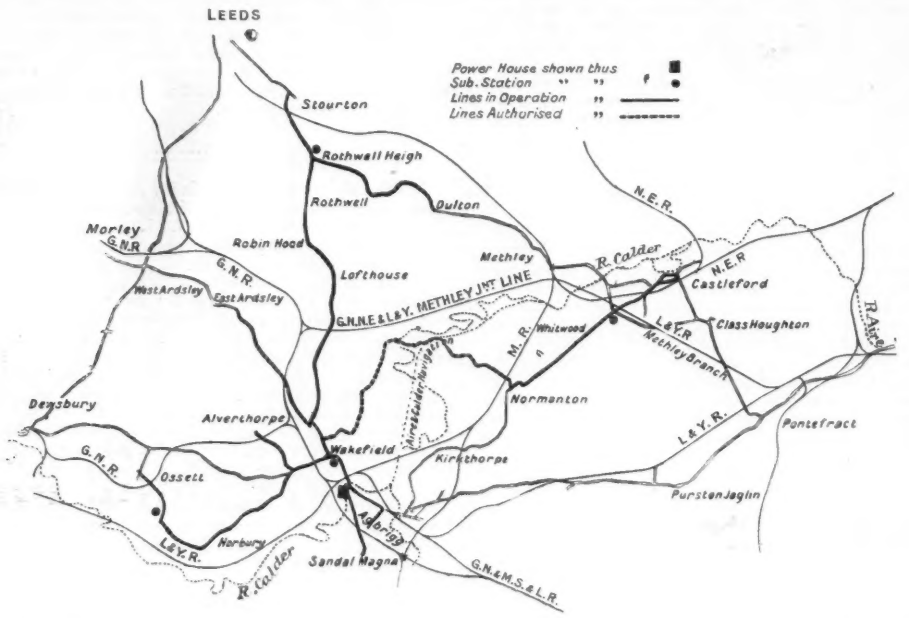
The Japanese battleship Yoshima, whose loss by mines last June is now officially admitted by the Japanese, was an Elswick-built ship of the Royal Sovereign type, with hoods to the big guns. Her loss keeps up the curious record of the war, that the Russians, though beaten, have destroyed more than they have lost. Japan has lost two first-class ships, Hatsuse and Yoshima; Russia but one battleship. On the other hand, while Japan has lost but one cruiser—by collision—Russia has by neutral ports lost one battleship and two cruisers. She has had also two cruisers of small fighting value sunk. We do not know the condition of the ships at Port Arthur. It is probably bad; but if otherwise, then things are by no means settled in the matter of naval superiority.

The latest story of the loss of the Yoshima is that she was sunk by one of the two small submarines which Russia has or had—despite denials—at Port Arthur. For ourselves, we do not credit the tale; had a submarine done it Russia would have let the world know the fact.

A well-known firm at Odessa, engaged in the manufacture of cocoanut oil, has at the present time twenty oil presses in use. Of these the four original machines were manufactured in the United Kingdom, while the remaining sixteen are from Germany. The latter, according to the British Consul, give the best results, and the pressure being far greater—some 200 to 300 atmospheres to the square inch—produce a much larger percentage of oil. The British-made presses are doubtless of old construction, and it is probable that machinery produced in the United Kingdom at the present day would be as effective as the German machinery now in use; but the fact remains that sixteen out of the twenty presses referred to are of German manufacture.

WAKEFIELD AND DISTRICT LIGHT RAILWAYS.

THE formal opening and inspection of the Wakefield and District Light Railway Company's system took place on Thursday, November 3rd, on the occasion of the visit of the Association of Tramway and Light Railway Officials to hold their eighth annual conference in that city. These tramways have been constructed and provided by virtue of the Wakefield and District Light Railway Order of 1901 for the service of Wakefield, Horbury, Alverthorpe, Sandal, and Outwood, and the Extension Order of 1902, which provides for the service of Horbury, Ossett, Sandal Magna, Lofthouse, Thorpe, Rothwell, Oulton, and also East Ardsley and Outwood. The powers then obtained have been carried out, with the exception of that for the service of Alverthorpe in the initial Order, and with the exception of Rothwell, Oulton, East Ardsley, and Lofthouse in the Order of 1902.



WAKEFIELD DISTRICT LIGHT RAILWAY NETWORK

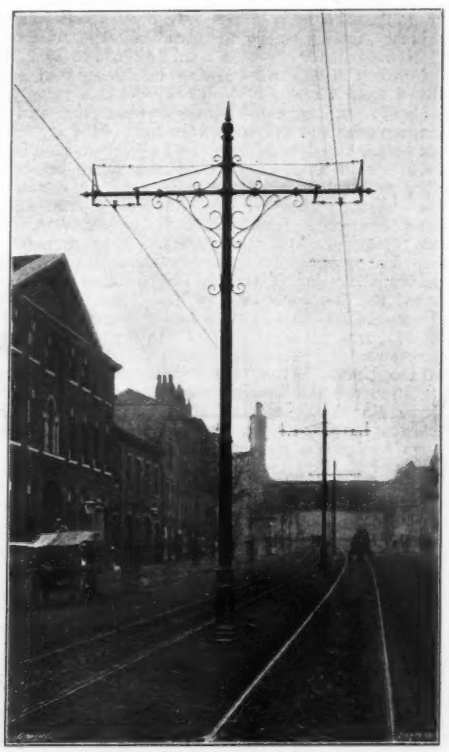
The central starting point is the Bull Ring, Wakefield. Although Stourton, within some fifty yards of the Leeds tramway system, is the limit of the company's present powers, arrangements have been made between the two companies for mutual running powers. Wakefield people will thus be enabled to travel by tram to the centre of Leeds without the necessity of changing cars. The Wakefield Company has also taken over the powers of the West Riding Tramways Company to construct tramways between Normanton and Castleford, between Castleford and Pontefract, between Pontefract and Knottingley, and between Pontefract and Purston and Jaglin. The company has 64 miles of track and 45 miles of route authorised and partly under construction, see the above plan.

The premises, formerly known as the Belle Isle Dye Works, have been converted into a central power station, where are situated the central offices of the company. Here, too, have been erected car sheds. At Rothwell, Haigh, and Castleford are further car sheds, sub-stations, and offices. Part of the Strafford Arms Hotel has been obtained for a city parcel office and waiting-room, &c., for the convenience of tramway passengers. In Union-street, Wakefield, is another sub-station.

The central power station is fitted with three sets of 400-kilowatt generators, driven by high-speed generators, each of 850 indicated horse-power. There are four Lancashire boilers, each nominally of 500 horse-power, measuring 30ft. by 8ft. A fifth will be placed in position very shortly. The boilers have "Lord" furnaces and hand-fired mechanical stokers. There are a Green's fuel economiser, a water storage tank with a capacity of 20,000 gallons of water, and two feed pumps capable of delivering 24,000 lb. of water per hour against a pressure of 150 lb. The feed-water is drawn from the river Calder and town supply, the water for condensing purposes being wholly taken from the river Calder. Three "Howden" high-speed triple-expansion condensing engines have been supplied, working at a steam pressure of 150 lb., running at 375 revolutions. The generators are Dick, Kerr and Co.'s standard high-tension alternators, which generate three-phase current at 6300 volts, 25 cycles, each set being provided with direct-driven exciter. They are "star" connected All three machines are designed to run in parallel with each other, means being provided for raising their voltage up to 6600 to compensate for loss in the mains when required.

A double car shed erected on the site of the old dye-house will accommodate thirty-five cars. The sub-stations are provided with rotary converters of 200 kilowatts, and the necessary equipments of switchboards, &c., for controlling the current. The power-station machinery at present installed has an output of 1200 kilowatts normal, and is capable of dealing with an overload of 50 per cent. for short periods. The current is generated at the high pressure of 6600 volts, and transmitted by three core cables to the various sub-stations. It is here transformed down to a pressure of 340 volts, and passes to rotary converters. It is here converted into direct current at 550 volts, and is supplied to the line. The sub-stations are fed from the main station by duplicate three-core, high-tension lead-covered cables. At the Wakefield sub-station there are three standard Dick, Kerr 200-kilowatt compound-wound rotary converters, running at 750 revolutions per minute, generating direct current at 500 to 550 volts. Each rotary has its complement of single-phase, oil-cooled, step-down transformers. The rotaries are capable of dealing with an overload of 25 per cent. for one hour. The Rothwell sub-station is similar to that at Wakefield, but is equipped with two rotaries, with the necessary transformers and switch gear.

The cars, of which the company possess eighty—one-half of them fitted with roof covers—are of the standard reversed staircase type, 27ft. 5in. length, the seating capacity being twenty-two inside and thirty-four outside. The interiors are finished in moulded oak, with three plate-glass windows on each side, giving the cars a saloon-like appearance. The current for the lighting of the cars is obtained from the trolley wire, each car being supplied with fifteen 16 candle-power incandescent lamps. The cars, which are driven by means of two 25 horse-power motors, are mounted on Brill trucks of 21/ E type, suitably built to support the car bodies and to receive the motors and gearing. Two cross bars are provided to carry the motors at their centres, and they are cushioned on the side bar with draw and recoil springs. The axles are 3⅜in. in diameter, and are made of Siemens-Martin steel, capable of standing a tensile strain of 60,000 lb. The wheels are of chilled iron, and are 30in. in diameter. Each car is fitted with a complete Dick, Kerr standard equipment, consisting of two of Dick, Kerr's standard 25A traction motors. The controllers are of Dick, Kerr's standard D.B.I., Form C type, with metallic shield blow out. Means are provided in the controller for allowing either motor to be cut entirely out of service, and the car driven by the other. The controllers are especially arranged with resistances for emergency braking, operated by the driving handle, which may be utilised either when the car is proceeding forwards or backwards.



CENTRE POLE EQUIPMENT

The contract for the whole of the foregoing work was given to the firm of Dick, Kerr and Co., Limited, the consulting engineer for the scheme being Mr. B. D. V. Cooper. The following data will, no doubt, be of interest:—Such a system necessarily called for high-tension transmission, as it would have been impossible to work all the routes embraced in the extended scheme from one central station. One sub-station is in use in Wakefield, about one mile from the power station, where three 200-kilowatt rotary converters have been erected, another at Rothwell, with two 200-kilowatt rotaries, and there will eventually be another at Castleford, which is about 10 miles from the power station, and, ultimately, a fourth at Ossett. The roadway has been excavated to a uniform depth of 12½in. below the upper surface of the rails to receive an 8in. bed of concrete, to carry the paving for a width of 8ft. for single track and 17ft. for double track. The rails are of the girder type, weighing 94 lb. per yard, and are laid in 45ft. lengths, with a proportion of shorter lengths to allow for closures. The rails are generally in accordance with standard tramway practice—6½in. deep, with a groove of 1½in. They are used as a return conductor, the joints being of the plain type, secured with six-holed fish-plates, 24in. in length, and are double-bonded with 4/0 Neptune copper pin bonds. The construction of the overhead lines is for the most part carried out on the side-pole system, with bracket arms, with flexible suspensions. The poles, which have an over-all length of 31ft., and are made up in three sections of lap-welded mild steel, are erected about 40 yards apart on the straight and closer in curves, in holes of a depth of 6ft., and surrounded by from 6in. to 9in. of concrete. In towns and residential districts the brackets are fitted with wrought iron scroll work, of a neat design. The trolley wires are of hard-drawn copper wire, 2/0 S.W.G., having a diameter of ·348in., weighing 1935 lb. per mile, and with a breaking strain equal to 24 tons per square inch. At every half-mile along the route small cast iron boxes are fitted to the poles, each containing four 150-ampère "no arc" switch fuses. These boxes serve the purpose of dividing the trolley wire into half sections and cross connecting for the parallel running. The cable taken from these connecting boxes from the poles has the same section of copper as the trolley wire, and is insulated with vulcanised rubber. The engravings given herewith and on page 472 show views of the engine-house and of portions of the track. The various methods of carrying the overhead wires will be observed.

The stages are five in number—Wakefield and Leeds, Wakefield and Ossett, Wakefield and Agbrigg, Wakefield and Sandal, and Wakefield Town. There are, of course, many intermediate stages. The time-table provides for the cars on all the routes to start running at five o'clock in the morning for the convenience of the working classes, with a slow service up to eight o'clock. After that hour there will be a regular ten minutes' service of cars, unless it is found that in cases fewer will suffice. The service will continue up to eleven o'clock at night. On Sundays the cars start at 1.30 p.m.

The full development of the system is in the able hands of Mr. H. England, formerly manager of the Corporation Tramways at Sunderland. Mr. C. E. Davies is the resident engineer. All the routes formally opened on the 3rd inst. had been previously inspected by Majors Drewitt and Trotter, of the Board of Trade, and the lines certified for traffic. The standard gauge of 4ft. 8½in. having been adopted, admits of the "through running," which is certain to be rapidly adopted in other parts of the country.

There was a large attendance at the public inspection, including representatives of the Wakefield City Council, Ossett Town Council, Wakefield Tradesmen's Association, and other public bodies; Mr. H. S. Leon, chairman of the company; Councillor Smithson, chairman of the Leeds Tramways Committee; Mr. J. B. Hamilton, general manager of the Leeds Tramways; and Mr. H. England, the general manager. The party were conveyed in special cars from the Market-place, Wakefield, to the terminus at Thwaite-gate. The Rothwell Haigh sub-station was inspected, and on the return journey the party were conveyed to Belle Isle Works, where they were much interested in what they saw, the manager and other officials giving explanations.

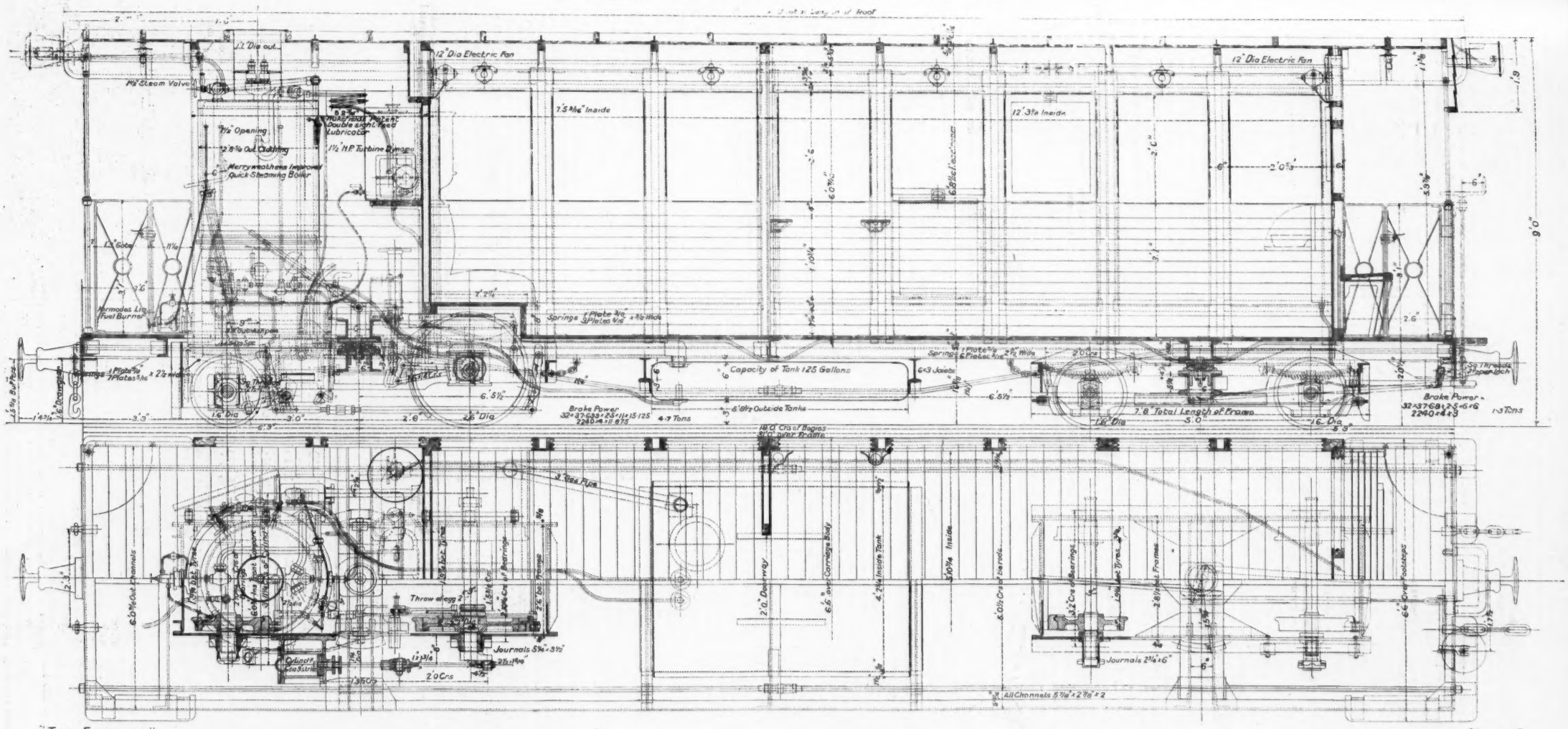
ROYAL INSTITUTION.—A Christmas course of lectures, adapted to a juvenile auditory, will be delivered by Mr. Henry Cunynghame, C.B., on "Ancient and Modern Methods of Measuring Time"—experimentally illustrated. The dates of the lectures are December 27th, 29th, and 31st, 1904; January 3rd, 5th, and 7th, 1905.

THE VICTORIA UNIVERSITY OF MANCHESTER.—The portraits of Professor Osborne Reynolds, LL.D., F.R.S., and Professor A. S. Wilkins, Litt.D., LL.D., by the Hon. John Collier, will be formally handed over to the University at a meeting which will be held on Friday, November 18th, at 2.30 p.m., in the Whitworth Hall. The Master of Peterhouse—Dr. A. W. Ward—formerly Principal of the Owens College, and Vice-chancellor of the Victoria University, has consented to make the presentation on behalf of the subscribers.

THE MOTOR VOLUNTEER CORPS.—The second "Volunteer Year" since the formation of the Motor Volunteer Corps came to a close on Monday last, and it reflects great credit on its members to hear that with very few exceptions they have all rendered themselves "efficients." During the past year the popularity of the motor in military service has been clearly demonstrated by the constant demands which have been made upon the Corps, and the fact that in every instance these demands have been complied with, and the various services successfully carried out, is ample proof, if any were needed, that the efficiency and utility of this latest branch of our Volunteer forces has been indisputably established. The good work it has done and the assistance it has rendered to military officers engaged upon important duties, which necessitated all expedition possible, has evoked from general officers throughout the kingdom voluminous congratulations, and on nearly every occasion upon which the Corps has been employed the satisfaction it has given has been invariably favourably commented upon by the commander under whose orders the duties were performed. The growth of the Motor Volunteer Corps has been highly satisfactory, when the unique nature of its composition and the conditions of service are considered, and further, that it is even yet only in its infancy. Its establishment is laid down at 203 all ranks, though its present strength is only 155, and whilst it has been wisely decided that only owners of suitable cars and expert cyclists should be enrolled, we feel sure that it only requires to be more generally known amongst patriotic motorists that vacancies exist in the Corps, to ensure its ranks being completed at no distant date. The duties performed have consisted chiefly of Staff rides, manœuvres, tactical examinations, and exercises, &c. &c., and the knowledge of the country possessed by its members has on many occasions proved of inestimable value to general officers. During the year the aggregate duties carried out by the Corps totalled 1289. Many of the car owners have travelled considerable distances on military duty. Several have exceeded 3000 miles during the year, whilst Captain H. F. Trippel has established quite a record by covering a distance of 4031 miles, on exclusively military duties, since the 29th April last. Several of the cyclists have also covered many miles of country on military duty, and during the recent Army Manœuvres some of the cyclists recorded from 150 to 200 miles daily. In this connection, it is as well to state how exceptionally useful the cyclists of the Corps have been found. Their rapidity has placed them in a position of the chiefs of dispatch riders, whilst for the same reason they have been found invaluable for reconnoitring purposes.

STEAM MOTOR COACH FOR THE MAHARAJA SCINDIA

MESSRS. KERR, STUART AND CO., LIMITED, STOKE-ON-TRENT, ENGINEERS



STEAM MOTOR COACH.

THIS steam motor coach was designed and built by Messrs. Kerr, Stuart and Co., Limited, 20, Bucklersbury, London, E.C., and Stoke-on-Trent, for the private use of H.H. the Maharaja Scindia of Gwalior, for running on his 24in.-gauge railways—known as the Gwalior Light Railways—which are some 250 miles in length. This coach will enable his Highness and suite to traverse the system at a speed of 20 miles an hour. We believe that this is the first modern type of motor coach which has been built for running on such a narrow gauge, and consequently a short description will be interesting to our readers.

A general outside view of the coach is given in the accompanying illustration, and from this it will be seen that, not withstanding the narrow gauge of the railway, there is ample stability for running at the above-mentioned speed. The total length is 31ft., and the extreme width 6ft. 6in. The interior is divided into two saloons. Double roofs, with a free air space between, are provided, but "sunshades" have been abandoned. Each window is fitted with glass tinted purple, and with louvre shutters, and both slides have catches to hold them in any position. In addition, handsome brocaded silk curtains of green and gold have been supplied. The outer panelling is of sheet steel; the entire woodwork is of teak, and the main and bogie frames of steel.

Very considerable taste has been shown in the selection of the internal decorations. The whole of the interior teak work, including fascias, mouldings, and pillars, is finished smooth and dull, and relieved by "Liberty" decorations and fittings of dull hammered oxidised copper and blue enamels. The division between the two saloons is formed by a partition with a central arch. The arch is draped with rich silk embroidered and brocaded curtains, and the walls of the partition covered with mirrors framed in hammered copper and blue enamels. The floors are covered with dark green Wilton carpets. The farther, or smaller—ladies'—saloon has an artistically designed cabinet, a fitted teak bookcase, and a very richly upholstered divan. In the larger saloon movable armchairs, varying in design to suit the individual comfort and taste of the passengers, are supplied, all being of teak, finished smooth and dull, with copper reliefs.

The lighting of the coach is done by means of incandescent lamps, the current being generally by Kerr, Stuart and Co.'s special steam turbine system. This system, by the way, although dispensing entirely with storage batteries, allows of lighting even when the coach is not running. Two powerful Bleriot head lamps are provided—one at each end—for night running. Ventilation is secured by two fans electrically and independently driven, and, like the lighting, the ventilation does not stop when the coach is not travelling. A well-appointed lavatory is also provided. The two saloons, the outer platform, and the engine compartment are provided with telephones, speaking tubes, and electric bells, so that communication is simple.

The engine bogie carries the boiler, and thus forms a complete separate locomotive, which can be detached from the coach framing. The boiler, which is of a quick steaming vertical type, can be fired either by coal, wood, or kerosene, and full pressure steam can be raised in it from cold water within twelve minutes. The working pressure is 140 lb. per square inch. All eight wheels of the coach are fitted with brakes, and these can be applied from either the engine compartment or the entrance platform.

The outside panels are painted ivory white and gold, and very beautifully finished.

Below are the leading dimensions:—

Diameter of cylinders	6in. by 9in. stroke.
Diameter of driving wheels	30in.
Diameter of other wheels	18in.
Wheel base of engine bogie	5ft. 6in.
Ditto, carriage bogie	5ft.
Gauge	24in.
Tank capacity	125 gallons.
Heating surface	162 square feet.
Grate area	6·6 square feet.
Length over buffers	33ft. 9½in.
Length of carriage body	31ft.
Width of carriage body	6ft. 6in.
Width of roof	7ft.
Total height from rail level	9ft.
Total weight of engine and coach empty	11 tons 1 cwt. 2 qr.
Ditto, in full working order	12 tons 7 cwt.
Tractive power	1340 lb. at ¾ cut off.

OBITUARY.

ROBERT JOHN BILLINTON.

We regret to say that Mr. Billinton died, after a lingering illness, at his residence, Lea Hurst, Withdean, Brighton, in the early hours of November 7th, at the age of 60. By his death the London, Brighton and South Coast Railway has lost an officer who had a large share in the rapid progress made by the company in recent years. He co-operated with the directorate and principal officers in adding to the efficiency of the line, gave close personal attention to alterations that have made travelling more comfortable and speedy, and the carriage of freight more expeditious. The late Mr. Billinton was a native of Wakefield, Yorkshire, his father being a railway contractor. He commenced his engineering career in the works of Sir William Fairbairn, in Manchester. Later, he joined the engineering staff of the late Mr. James Simpson, in London. Then for several years he had a wide general experience in the shops of various contracting engineers, principally in the manufacture of steel plant and general engineering work.

Mr. Billinton was also at one time connected with the Yorkshire Engine Works. His first introduction to Brighton dates back to the year 1871, when he took charge of the drawing-office. He came straight to that position from the North of England. But his association with the Brighton Railway was of short duration, for four years later, in 1874, he severed his connection with the drawing-office, and returned to Derby—he had previously been at Derby before—as chief draughtsman, under Mr. S. W. Johnson, the locomotive superintendent of the Midland Railway. It was while thus engaged that Mr. Billinton gained the experience which in later years was of inestimable value to him in his higher position on the Brighton Railway. During that period he assisted in the designing of the standard types of the Midland Railway locomotives, the last class being the famous 7ft. 6in. single-driving wheel express engines, one of which was exhibited at the Paris Exhibition of 1889. He remained in the position of chief draughtsman to the Midland Company until December, 1889, when he was appointed by the directors locomotive, carriage, wagon, and marine engineer of the London, Brighton, and South Coast Railway, thus re-entering their services after a lapse of fifteen years. Mr. Billinton succeeded the late Mr. Stroudley, and took over his new duties on February 1st, 1890. In many ways Mr. Billinton vastly improved the rolling stock of the London and Brighton Railway. Among the noteworthy features which Mr. Billinton introduced on the Brighton Railway was the building of all the express engines with a bogie, and also a number of bogie tank engines for working in the suburban districts; he was also a supporter of the radial wheel for large tank engines, having three pairs of coupled wheels. Another great improvement introduced was in the higher-pitched roofs of the carriage stock, also six-wheeled carriages and bogie carriages superseding the four-wheeled stock. Gas or electric light has been applied to every carriage on the system. Quite a large number of lavatory carriages are now running on the various lines of the company, this also applying to first, second, and third-class carriages. Steel underframes for the carriages have superseded wood, thus greatly adding to the strength of the coach. Last year, through his agency, bogie wagons of large carrying capacity were introduced.

During Mr. Billinton's *régime* the train mileage has increased 22 per cent., the engines 30 per cent., the carriages 13 per cent., and the wagon stock nearly 34 per cent. The rolling stock actually built under his direction was 317 engines, 1839 carriages, and 8377 wagons. The staff had likewise been enlarged by 45 per cent., from 3247 in 1890 to 4711 at the present day. There are also now 40 per cent. more drivers and working staff than when he accepted the appointment of locomotive engineer. Mr. Billinton considerably enlarged the Brighton works, and introduced the latest machinery and appliances for turning out the work in an expeditious manner. He built a new carriage, paint, and trimming shop, at Preston Park, considerably enlarged the boiler shop at the Brighton works, built a new steel carriage underframe shop, lengthened the erecting shop, also a new wheel and press shop, new smiths' shop and turning and machine shop.

Following immediately, as he did, that master mechanician William Stroudley, his position was difficult. None the less was he successful. Mr. Stroudley did not like bogie engines, and his express locomotives with the leading wheels coupled were so successful that they justified views by many of his contemporaries held as unorthodox. But the demands of traffic increased, and Mr. Billinton built some very handsome bogie engines quite soon after he went to Brighton. His most remarkable work, however, is represented by the exceptionally large locomotives of the Empress and Sirdar class, the first of which began running in 1900. These locomotives were fully illustrated in our issue for January 7th, 1901, and other impressions. The engines have been criticised because of the very short and inconvenient footplate. But there are no very long continuous runs possible on the London and Brighton Railway, and the wheel base of the engines is now as great as the turntables can take in.

Throughout he carried out the duties of his office to the satisfaction of his directors, and by his kindly manner and genial disposition won the golden opinions of all with whom he worked. Mr. Billinton was a member of several engineering institutions and societies. He was elected a member of the Institution of Civil Engineers in January, 1899.

DUNCAN STEWART.

The death took place at Eastbourne on 30th ult. of Mr. Duncan Stewart, of D. Stewart and Co., London-road Ironworks, Glasgow. He was founder of these works some forty years since, and up till two years ago, when his health failed, he was closely associated with them, and was one of the best known men in engineering circles in the West of Scotland. Born near Glasgow about sixty years ago, he received his early training in a small engineering works, in which his father was a partner, where bleaching and finishing machinery was the principal manufacture. As an apprentice he also took a great interest in sugar machinery, and spent much of his spare time in the large sugar works at Greenock, mastering the details of the manufacture itself, which study afterwards proved of great service to him. On the death of his father in 1864, and when only twenty years of age, he started the firm of Duncan Stewart and Co., the number of employés at first being only about a dozen. As business increased the works were gradually enlarged, until from 600 to 800 men were employed.

Soon after starting the works, Mr. Stewart was induced to accept an offer from a firm who were the owners of a large number of sugar estates in the West Indies to go out for a limited time as their chief engineer. The experience gained there and the friendships which he made proved of much value to his business, and he came back to Glasgow—having fulfilled his commission to the great satisfaction of his employers—with the nucleus of a business in sugar machinery which eventually made the name of his firm familiar in practically every sugar-growing country in the world. Large sugar factories have been erected by the firm in Java, Egypt, West Indies, Australia, Mexico, and South America. Not content with one class of work, Mr. Stewart set himself to build up a business in bleaching, printing and finishing machinery, with which he had made himself closely familiar in his father's time; and there are at present probably very few bleaching and finishing works of any importance in the British Isles which have not some of the firm's machinery in them, besides others on the continent of Europe, in India and America. In general engineering the firm also have supplied large rolling mill engines and hydraulic plant to steel works in all parts of the kingdom, also pumping engines of the largest size for work at home and abroad. Steam engines up to 2000 indicated horse-power have been supplied to cotton mills in this country, in France, and in India. Latterly, engines for electric lighting and traction have formed a notable product of the firm's industry. When the Glasgow Corporation resolved on the introduction of electric traction for the whole tramway system of the city, they were successful in obtaining a share of the contract for the engines for Pinkston power station, the larger portion going to an American firm. The relative merits of the machinery were keenly discussed at the time. The home-made engines were installed within the period specified, and it was owing to the promptitude of delivery, and the efficiency of the plant that the tramway system was opened in accordance with the original arrangements.

In connection with the various productions of his firm, Mr. Stewart's ingenuity and skill resulted in many patented features. One of his most successful inventions was the application of hydraulic pressure to the rolls in sugar mills, and what was originally known as Stewart's patent hydraulic attachment is now almost universally applied to mills where a high percentage of extraction is desired. Perhaps his most ingenious invention was that of the "continuous centrifugal machine," on which he spent a great amount of thought and much money. The difficulties to be overcome, however, proved too great, and the machine, in spite of its ingenuity, was not a commercial success.

Probably because of his early associations, Mr. Stewart always took a great interest in West Indian affairs, and it was with deep concern that he witnessed the decline of the sugar industry there. Through his able statement of the case to the then Colonial Secretary, Mr. Chamberlain, he succeeded in obtaining in 1898-9 a British Government loan of £250,000 for the establishment of central sugar factories. Unfortunately, Mr. Stewart was not destined to reap the fruits of his industry in this direction, as the South African war postponed the scheme, and his illness in 1901-2 removed him from the arena of active business in which he had been a strenuous worker for practically forty years. He married in 1879 the daughter of the late Mr. William Beardmore, of Parkhead Forge, and he is survived by her and by two daughters and two sons.

FRANK McCLEAN.

It is with regret that we have to record the death of Mr. Frank McClean, M. Inst. C.E., M.A., F.R.A.S., F.R.S., the distinguished engineer and astronomer, who passed away in his sixty-seventh year at Brussels on Tuesday. He was the only son of Mr. J. R. McClean, F.R.S., who was at one time President of the Institution of Civil Engineers. The early part of his education was received at Westminster School and Glasgow College. From there he went to Trinity College, of which foundation he was a scholar, and where he graduated in 1859 as a Wrangler. After leaving Cambridge he decided to follow the same profession as his father, and was apprenticed to Sir John Hawkshaw. After serving three years he became a partner in the firm of McClean and Stileman, civil engineers, and was engaged upon important dock and railway work, in connection with which may be mentioned the widening of the Ulverston and Lancaster Railway, the construction of the Barrow Docks, and the construction of the Furness and Midland Railway. In 1879 he practically retired from his professional duties, and devoted himself almost entirely to solar and stellar spectroscopic work, and since then has published many valuable papers on the subject. In 1874 he founded an astronomical observatory at Tunbridge Wells. He received the gold medal of the Royal Astronomical Society in 1899 for his astronomical contributions and for his photographic survey of star spectra in both hemispheres. The Isaac Newton studentships were founded by him in 1890, and at about that time he also presented the Victoria photographic telescope to the Royal Observatory, Cape of Good Hope. Mr. McClean was a Fellow of the Royal Society, and also the Astronomical Society. The honorary degree of LL.D. was conferred upon him by the Glasgow University in recognition of his valuable work. In 1865 Mr. McClean married Ellen, daughter of Mr. John Greg, of Escowbeck, Lancaster.

THE TARIFF COMMISSION.

The Tariff Commission has held eight further sittings at the Whitehall Rooms, under the chairmanship of Sir Robert Herbert, G.C.B., Mr. W. H. Grenfell, Mr. F. Leverton Harris, Sir Vincent Caillard, and Mr. Alfred Mosely respectively, making 71 sittings in all to date.

The last eight meetings have been chiefly concerned with the taking of evidence in regard to the engineering and machinery, textile, pottery, timber, carriage, and building, and india-rubber trades. The witnesses examined in each section were as follows:—

Engineering and machinery trades.—Mr. John Gwynne—Gwynnes, Limited, 81, Cannon-street, E.C., hydraulic and mechanical engineers; Mr. Wm. L. Madgen—The Brush Electrical Engineering Company, Limited, Victoria Works, Belvedere-road, S.E.

The textile trades.—Mr. J. E. Haggas—J. Haggas and Co., Ingrow Mills, Keighley, woollen spinners and manufacturers; Mr. Wm. Murgatroyd—W. Murgatroyd and Co., Moorfield Mills, Yeadon, near Leeds, woollen manufacturers; Mr. H. Ives—James Ives and Co., Leafield Mills, Yeadon, Yorks., woollen manufacturers; Mr. F. Learoyd—Learoyd Bros. and Co., 5, Golden-square, W., and Trafalgar Mills, Huddersfield, woollen and worsted manufacturers; Mr. J. Peate—J., J. L., and C. Peate, Nunroyd Mills, Guiseley, near Leeds, cloth manufacturers.

The pottery trades.—Mr. John Ridgway—Ridgways, Bedford Works, Shelton, general earthenware manufacturers; Mr. F. Rawdon Smith—Craven Dunhill and Co., Limited, Jackfield, Shropshire, decorative tile manufacturers; Mr. John. S. Goddard—S. L. Ashworth and Bros., Hanley, earthenware manufacturers; Mr. T. C. Moore—Shelton, Stoke-on-Trent, chairman of the Parliamentary and Tariffs Committee, Staffordshire Chamber of Commerce, formerly manufacturer of pottery ware; Mr. T. B. Johnston—Pountney and Co., Limited, Bristol, earthenware manufacturers.

The timber trade.—Mr. S. B. Boulton, founder and first president of the Timber Trade Federation—Burt, Boulton and Haywood, Limited, 64, Cannon-street, E.C., chemical manufacturers and timber importers; Mr. W. V. K. Stenning, chairman of the English Timber Trade Section of the Timber Trade Federation—John Stenning and Son, Limited, 11, Clement's-lane, E.C., British timber merchants; Mr. Charles Hopton, deputy chairman of the English Timber Trade Section of the Timber Trade Federation—Hopton and Sons, 67, George-street, Euston-square, N.W., and Union Works, Market Harboro', timber merchants, bent timber and carriage wheel manufacturers; Mr. Ward Layle, vice-president of the Timber Trade Federation—English Bros., Limited, Wisbech, timber importers and preservers; Mr. W. C. Williams—Joseph Owen and Sons, Stanley-road, Liverpool, English and foreign timber merchants.

The carriage trade.—Three representatives of the Institute of British Carriage Manufacturers, 30, Moorgate-street, London, E.C.:—Mr. W. H. Hamshaw, 58, Hill-road, Wimbledon; Mr. Charles Holmes, 24, Aberdare-gardens, West Hampstead, N.W.; Mr. W. Lawton Goodman—J. A. Lawton and Co., 35, Hardman-street, Liverpool.

The building trade.—Mr. H. H. Bartlett—Perry and Co., Tredegar Works, Bow, E., builders and contractors.

The india-rubber trade.—Two representatives from the India-rubber Manufacturers' Association, 2, Cooper-street, Manchester:—Mr. F. Pegler—The Northern Rubber Company, Retford, Nottingham; Mr. J. E. Baxter—The Leyland and Birmingham Rubber Company, Leyland, near Preston.

Completion of the textile evidence.—The Commission has now heard seventy-four witnesses upon the following branches of the textile trades, namely:—Cotton, woollen and worsted, silk, flax, jute, hemp, and other fibres, lace, hosiery, carpets, and with the exception of additional witnesses to be heard from certain districts and branches the textile evidence has now been completed.

Agriculture.—The Agricultural Committee held a meeting at the Whitehall Rooms on Tuesday last under the presidency of Mr. Chaplin. The draft report upon the replies of agriculturists in all parts of the kingdom to the form of inquiry issued by the Committee were considered, and also further statistical tables and memoranda in regard to the present conditions of agriculture. The Committee considered the points upon which additional evidence is required and made arrangements for taking the evidence of witnesses representative of the different branches of agriculture in England, Scotland, Wales, and Ireland. The Agricultural Committee will now meet on Mondays and Tuesdays of alternate weeks to hear witnesses.

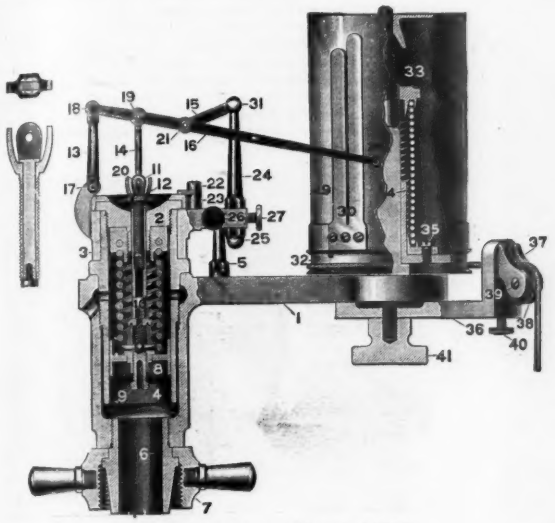
The Institute of Sanitary Engineers, Limited.—The undermentioned meetings will be held on November 16th, commencing at 3 o'clock p.m.:—Election Committee, Examination and Literary Committee, Finance Committee, Organising Committee. Council meeting at seven o'clock.

Society of Arts.—The following arrangements have been made for meetings previous to Christmas, 1904:—Wednesday, November 16th, 8 p.m. (ordinary meeting): Inaugural Address of the 151st Session of the Society by Sir William Abney, K.C.B., D.C.L., D.Sc., F.R.S., Chairman of the Council. Wednesday, November 23rd, 8 p.m. (ordinary meeting): Ben. H. Morgan, "The Systematic Promotion of British Trade." Monday, November 28th, 8 p.m. (Cantor Lecture): D. J. Blaikley, "Musical Wind Instruments" (Lecture I.). Wednesday, November 30th, 8 p.m. (ordinary meeting): Arthur Lee, J.P., "The British Canals Problem" (the Right Hon. Sir Michael Hicks-Beach, Bart., D.C.L., will preside). Monday, December 5th, 8 p.m. (Cantor Lecture): D. J. Blaikley, "Musical Wind Instruments" (Lecture II.—Brass Instruments). Wednesday, December 7th, 8 p.m. (ordinary meeting): Walter Francis Reid, F.C.S., "The International Exhibition at St. Louis, U.S.A." Thursday, December 8th, 4.30 p.m. (Indian Section): Sir Frederic Fryer, K.C.S.I., "Burma" (the Right Hon. the Earl of Hardwicke will preside). Monday, December 12th, 8 p.m. (Cantor Lecture): D. J. Blaikley, "Musical Wind Instruments" (Lecture III.—Reed Instruments). Wednesday, December 14th, 8 p.m. (ordinary meeting): Charles D. Abel, "The Patent Laws." Monday, December 19th, 8 p.m. (Cantor Lecture): D. J. Blaikley, "Musical Wind Instruments" (Lecture IV.—Flutes). Tuesday, December 20th, 8 p.m. (Applied Art Section): Thomas Graham Jackson, R.A., "Street Architecture."

The Development of Dalmatia.—Travellers in South Europe who wish for newer scenes than those of the beaten tracks in Italy could hardly do better than take a trip to Dalmatia, the southernmost Crown land of the Austro-Hungarian Empire. Thanks to the efforts of the Ungaro-Croata Steam Navigation Company, there is now a splendid service of first-class mail steamers running between Fiume and the many picturesque ports. Fiume, at the head of the Adriatic, is the best starting point, and from there the Ungaro-Croata boats sail to every place of interest along the coast. The country is replete with interest, full of historic lore and fine relics of a magnificent past, when Romans or Venetians ruled the land, and it is picturesque beyond measure. The people are chiefly Servian-Croatian, with an admixture of Italian. Of the many beautiful spots to be seen in Dalmatia, mention may be made of the famous Falls of Kerka. A visit to them makes a very pleasant driving excursion from the port of Sebenico. Lower down the coast is Spálato, a fascinating little town on a peninsula encircled by lofty hills. From here a little cruise can be made to the pretty islands of Lissa and Busi. In the latter is a wonderful cave resembling the renowned Blue Grotto of Capri. It is lighted by a submarine gateway, so that while the vault is in pitch darkness the water glitters in exquisite azure tints. The furthest point touched by the Ungaro-Croata Company's service of steamers is Cáttaro, approached through the beautiful "Bocche di Cát'aro," a great fjord or arm of the sea cutting deep into the mainland and opening out into five most lovely bays, from which the mountains rise steeply to nearly 6000ft. These bays are connected by narrow channels. The latest addition to the fleet of the Ungaro-Croata Company is a smart mail steamer which has just left the Neptune Works of Swan, Hunter, and Wigham Richardson, at Walker-on-Tyne. The vessel is called the Salona after a small town of that name, which is now a mere village, though it was once an important Roman naval depôt and arsenal, and the ruins of the stronghold still occupy all the heights round the magnificent bay. Several of the steamers of the Ungaro-Croata Company have been built at the Neptune Works of Swan, Hunter, and Wigham Richardson. The Salona is 234ft. in length by 30ft. beam, and is built to the highest class at Lloyd's, under special survey. The engines, also constructed by Swan, Hunter, and Wigham Richardson, are four-crank quadruple-expansion, balanced on the well-known Yarrow, Schlick and Tweedy system. There is accommodation for sixty-five first-class and for twenty-four second-class passengers. Electric light has been installed throughout the entire ship. The first-class saloon on the main deck is luxuriously furnished and well ventilated. The walls of polished oak embrace fine panels of "gesso" work depicting seascapes and land views. They have been executed by Mr. Rushton, of the Art School in the Armstrong College, Newcastle-on-Tyne. The trial trip of the Salona was run on 2nd November off the mouth of the river Tyne and proved an entire success. A speed of 14½ knots was attained. The Ungaro-Croata Company was represented by its inspector, Mr. A. Sverljuga, and Captain Prossen, who commands the ship, and Mr. Bertotti, the chief engineer.

A NEW STEAM ENGINE INDICATOR.

In the accompanying sectional illustration is shown an indicator on the Thompson lines, but with several improvements in detail which are worthy of notice. As will be observed, the pencil movement is not original. One of the improvements which the makers, the Star Brass Manufacturing Company, of Boston, have introduced consists in the attachment of the cap at the top of the cylinder to the interior shell within which the piston moves and not to the outer shell, thus producing a more correct alignment for the motion of the piston and rod. The interior cylinder is, nevertheless, movable, and, moreover, is surrounded by a jacket space filled with live steam, which causes the parts to expand equally. Another good feature is the means for unscrewing and removing the cap from the cylinder with the parts attached to it. The cap has a milled edge of the usual construction, but, unlike some other instruments, the edge is protected by a hard rubber non-conducting covering. This covering can be handled with absolute comfort to any one using it. Another thing which will be appreciated is the provision of a vent tube for carrying away the waste steam and hot water which blows by the piston. This tube is attached to the side of the cylinder, and it extends some distance below the body of the instrument, thus preventing the hot water which is mixed with the steam from dripping on the hand of the operator while in the act of turning off



THE STARR BRASS INDICATOR

the indicator cock. The piston-rod is provided with an adjustable swivel head, so arranged that the position of the pencil arm can be varied and the atmospheric line drawn at any desired distance from the lower edge of the card, without removing the piston and its mechanism from the cylinder. A new form of detent motion is furnished, consisting simply of a ball which is thrown into contact with a groove in the circumference of the drum base. If it is desired to change from right to left hand, it is only necessary to remove the drum by a straight upward pull; then, with a screw driver, remove the stop screw in the drum base, and screw it into a hole purposely provided; next, reverse the position of the adjusting handle in the arm; also the position of the metallic point in the pencil lever; then replace the drum, and the change from right to left will be completed. The European agents for this instrument are Messrs. Green and Boulding, Limited, 28, New Bridge-street, London.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

STEAM TRACTION ON COMMON ROADS.

Sir,—I was greatly interested in your able leader of November 4th regarding the noises produced by traction engines and motor wagons, and heartily agree with you that silence in this class of machinery is more than golden, and makers should aim at reducing noise as much as possible, knowing, as they do, that silence in working and durability go together, rendering the most silent machine most popular.

About 1879 I suggested the use of rubber or some elastic material being used around the hubs of driving wheels in traction engines. I do not think that spring wheels will be revived for traction engines or very heavy motor wagons, but such wheels may come into use for light tractors and small motor wagons, and give excellent results.

In justice to many of the leading makers of machinery for self-propelled road traffic, I must say that much has been done by them in recent years in the direction your leader suggests.

I have the pleasure to represent a firm who are turning out road locomotives which are practically noiseless, owing to their special arrangement of compound engines, highly sensitive spring gear, carefully balanced moving parts, lock nuts, spring washers, &c. &c.

I invariably find that when a modern high-class road locomotive is employed that the wagons or trailers hauled by such an engine, especially when running empty, are responsible for the greater part of the noise produced. The same remark applies to motor wagons themselves and their empty trailers. Makers should bear this fact in mind, and turn their attention to reducing still further noise. I must admit that there are in use on our highways many obsolete traction engines. These must not be compared for a moment with the best present-day practice; it frequently happens that the users of road locomotives and motor wagons are greater sinners than the makers, so far as noise is concerned; users of such machinery on a public highway should be made as liable for making preventable noise as for smoke, blowing off steam, &c.

Doubtless the 156 good people in the parish of Marylebone are annoyed by preventable noise, owing, perhaps, to some by-law which compels motor wagons and traction engines to pass through their district in the otherwise silent hours of early morning. It is also very probable that could such traffic pass about mid-day no one would notice it from an extraordinary noise point of view.

I know that two wrongs do not make a right, but beg to remind you that the self-propelled traffic on our common roads is not responsible for a tithe of the disagreeable noises common to this progressive manufacturing kingdom of which we are all so proud. I for one would be sorry to think that it was likely to return to pack-saddle days and become silent, for many centuries to come at least.

What of our great railway traffic which runs through the country twenty-four hours round; our tramway service from 5 a.m. to midnight, and last, but not least by any means, our great horse-drawn traffic, especially empty springless carts, passing over paved streets. Truly we are a people hard to please. Sir Walter Gilbey, in his article on "Motor Wagons," in this month's *Nineteenth Century*, claims that a noisy vehicle is safer for the passing public than the comparatively silent self-propelled vehicle. The following are that gentleman's exact words:—"It seems worth pointing out that the danger to others from the old fast coach was infinitely less than the danger from the motor car travelling at the same pace—ten miles per hour. The rumble of the wheels and thunder of hoofs proclaimed the approach of the former from a long distance."

I simply refer to the noises produced by other traffic, with a view of proving that the self-propelled traffic on our common roads is not nearly so bad as it is painted; and I am fully convinced that makers and users of the latter class of machinery can make it the most silent means for transporting goods over common roads. If such can be accomplished, your article will not have been written in vain.

JAMES ROBINSON.

Leeds, November 7th.

Sir,—I have read your leading article on this subject in your last issue with interest, but by your permission I should like to make a few remarks respecting the historical portion of the article. You appear to give to Messrs. Aveling, of Rochester, and Mr. John Smith, of Coven, the honour which scarcely belongs to them. As far as possible I will give the history of the traction engine previous to the year 1862, with dates and brief particulars. Your readers can then form their own conclusions. Nathan Gough, of Salford, undoubtedly made the first traction engine for hauling loads at slow speeds. The late Mr. I. W. Boulton saw this engine at work in the Manchester district, and furnished some particulars of it. The next traction engine put to agricultural work was "The Farmer's Engine," designed by Mr. Robert Willis, of the Railway Foundry, Leeds, in 1849. The engine was arranged beneath the boiler barrel. It was exhibited at the Norwich Show in 1849, and carried off the first prize the same year at Leeds.

In 1855 the first Boydell engine was made by Messrs. Burrell and Sons. Bray's engine appeared in 1856. A small self-propelling engine was at work in Lincolnshire in 1857. Messrs. Burrell the same year introduced a small traction engine, which was at work in various parts of the country, and particularly at Salisbury during the Show week. It was a chain engine, and was not fitted with the Boydell endless railway. The same firm continued to make engines on these lines for many years. Blackburn made a curious traction engine in 1858. Longstaff and Pullan's traction engines were made by Gardiner and Mackintosh in 1858. They were fine engines. The whole of the bearings for the shafts and axle were carried at the fire-box end by two strong side plates, very much in the same manner as is now adopted, but their side plates were hung on springs. In one arrangement the axle and shafts were all in one vertical line, a considerable portion of the spur gearing was placed between the horn plates inside the bearings. See sketch of this detail in THE ENGINEER for April 8th, 1881.

In 1858 Messrs. Clayton and Shuttleworth made a Boydell engine for shipment to Odessa. The same year Mr. John Smith, of Coven, built a few engines of the type which was illustrated in THE ENGINEER for 4th September, 1896; the working parts were fitted between two deep side-plates; the engines did very well. In 1858 Gough, Chaplin, Tuxford, and Holmes made traction engines. Taylor, of Birkenhead, constructed a number of powerful road locomotives, which he termed "steam elephants."

The same year Messrs. Clayton and Shuttleworth commenced to build traction engines in many points identical with modern practice. The cylinder was steam-jacketed, and placed at the smoke-box end of the boiler barrel; the crank shaft and main axle were situated at the fire-box end of the boiler. Another striking feature in use by this firm at this early date was spur gearing for transmitting the power from the crank shaft to the axle.* Many of the traction engines of that day used chain drives.

It is a well-known fact that the late Mr. Thomas Aveling commenced his career as a self-moving engine maker, by adding a chain and suitable gearing to the portable engines made by Messrs. Clayton and Shuttleworth. In his traction engine of 1859 the cylinder was placed at the fire-box end, and the crank shaft brackets at the fire-box end in the usual portable engine fashion. A spur pinion on the crank shaft drove a corresponding wheel on a stud carried by the crank shaft brackets. On this stud a pinion revolved, which communicated motion to the axle by means of a pitch chain. In 1859 Barran's traction engine was built by Messrs. Whitham and Sons, Leeds. This was shipped to California to transport copper from the mines to the railway. Mr. Aveling patented the pilot steerage in 1860, but this was invented by Andrews in 1826, and used by Gurney in 1828. The pilot steerage or fifth wheel was used by Mr. Aveling until 1869. In April, 1860, Messrs. Clayton and Shuttleworth sent a traction engine to the Dublin Show. Messrs. John Fowler's traction engines were introduced about this time also; their ploughing engines were first made some years earlier. From the above it will be seen that Messrs. Burrell and Messrs. Clayton and Shuttleworth have not followed the lead set by the names mentioned; they were making traction engines before Messrs. Aveling or Mr. Smith. In justice to some of our real pioneers I hope you will allow this letter to appear.

W. FLETCHER.

Lincoln, November 8th.

[Our correspondent has, we think, failed to grasp our meaning. We did not claim for Mr. Aveling or Mr. Smith the invention of self-propelled engines for moving on common roads, which were in more or less experimental use from a very early period, but that to them is mainly due the evolution of the now all but universal type of traction engine, differing widely in essential details from the Farmer's engine, Boydell's, and many others constructed antecedent to 1860.—ED. E.]

AIR PUMP EFFICIENCY.

Sir,—After reading the correspondence of late appearing in your pages under the above head, I have come to the conclusion that there is some mathematical error introduced unconsciously in one of several ways—either Mr. Benn's readings have not been corrected for the temperature of the room in which his instruments are used, or parallax at time of reading his instruments has been neglected, or corrections for expansion of the mercury and expansion of glass containing it have not been made. The correct temperature of the discharge water would influence the tension of the vapour. Even the latitude of Haslingden must be taken into account if we are to have our instruments calibrated, as one correspondent suggests.

What I would suggest to Mr. Benn, if he is not a good mathematician, is to give the opportunity to some "expert" to verify the readings recorded by Mr. Benn's instruments, and also to use another set of instruments.

I am convinced that the readings of the instruments used, taken during a visit I paid to Rossendale especially to see the new principle involved, were correct, as quoted in Mr. Benn's first letter. Where the theoretical results differ from those obtained in practice, I am of opinion they arise from one of two causes.

(1) The physical measurements are taken by one not used to taking readings, and so introduce slight errors unconsciously, which, when only amounting to, say, one-hundredth part of an inch, become tall discrepancies when worked on the percentage method.

(2) The arithmetician has definite figures before him; his figures will not vibrate like the mercury in a tube in an engine-house.

I hope Mr. Benn may invite practical criticism in the shape of a visit to Haslingden from his London critics.

HENRY MILNE.

Hanley, Staffordshire, November 7th.

*THE ENGINEER, 10th December, 1897.

STORAGE BATTERIES.

Sir,—In your "Notes and Memoranda" of November 4th appears a short paragraph obtained from statistics from the Association of Central Stations in Germany, showing that the use of storage batteries causes an actual increase of 21·6 per cent. in the total price of the production of current.

I shall be glad if you will give me an opportunity of emphatically contradicting such an erroneous and misleading statement. In the first place, the figures as given are manifestly erroneous, or, at any rate, are based upon conditions of German manufacture of accumulators which certainly do not at present exist in this country. Here we are able to purchase and put down accumulators on a large scale, and on such terms of guarantee for maintenance and depreciation that the total cost per kilowatt hour for this latter charge need not exceed ·2 of a penny or 1·6 pf., so that, even adopting the 33 per cent. loss which is said to prevail in Germany, the total cost of production would be only increased by the use of accumulators from 10 pf. to 16·3 pf., in place of the 28 pf. mentioned in the extract.

From this correction it will be seen that in a case which is probably a very ordinary one, that 12 per cent. of the output is passed through the accumulators, the total cost of producing the energy will be only increased by about 7½ per cent. Against this small increase must be set the very great advantage of working the generating plant at a better load factor, which reduces the original cost of the whole of the energy by 15 per cent. or 20 per cent., so that the net gain by the use of accumulators is admittedly very large.

I have just returned from a long visit to America, where this question was fully debated at the recent St. Louis Conference, at a meeting at which the engineers of many electric supply undertakings in America were present, and I think all users of accumulators were very emphatic on the saving which had been realised by their use.

R. E. CROMPTON.

Kensington Court, London, W., November 7th.

A CENTENARIAN RAILWAY ADVERTISEMENT.

Sir,—Can any of your readers throw light upon the following curious advertisement, which appeared in *The Times* of November 9th, 1804—precisely one hundred years ago:—"TO MINERS, or Others whom it may concern. A RAIL-WAY and WAGGON has been invented, by which twenty tons can be drawn by one horse, or ten tons, at the rate of eight miles an hour, by one horse.

Plans, and an acting model may be seen, by application to Joseph Walker, the inventor, or to John Robinson, Pleasant-row, Kingsland-road, London. The Proprietor will treat with any person willing to employ this invention on liberal terms."

Neither of these names appear in the list of patentees of the period.

W. B. PALEY.

Chelsea, November 4th.

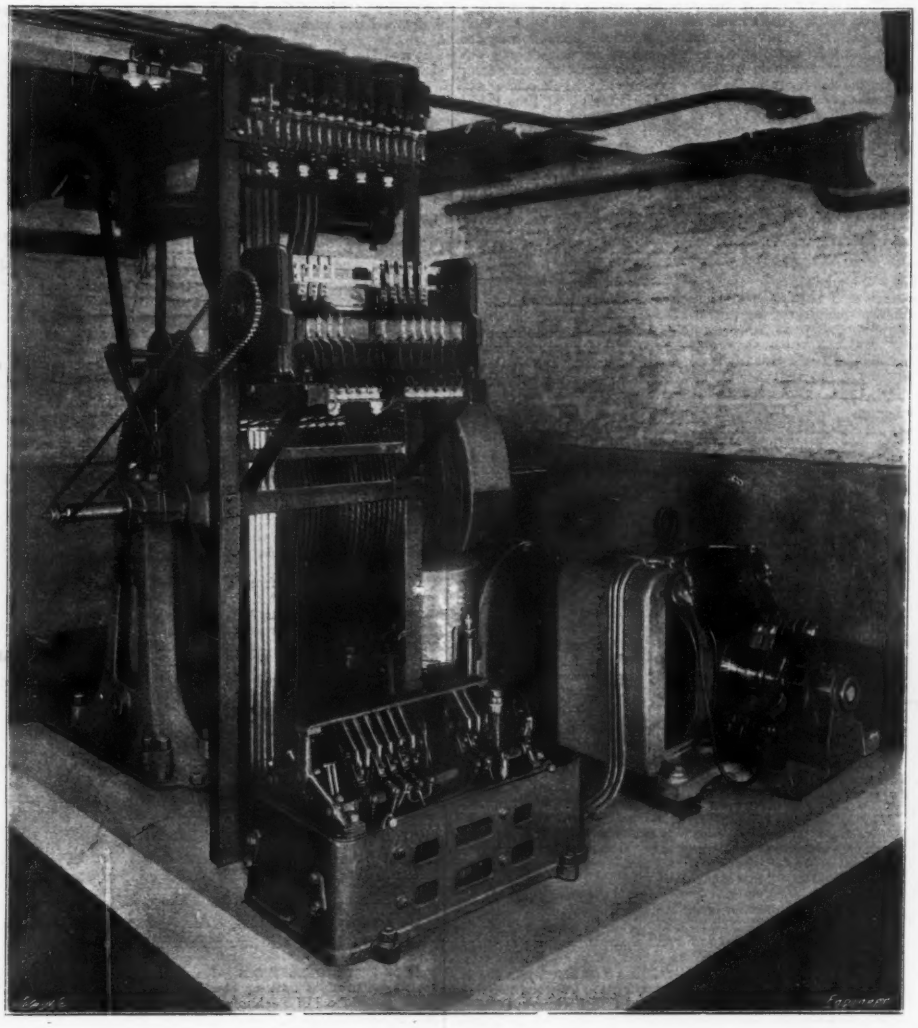
HIGH-SPEED STEEL TOOLS.—An important report on the experiments with rapid cutting steel tools made at the Manchester Municipal School of Technology in the presence of a general committee of members of the Manchester Association of Engineers, and a sub-committee of the School of Technology, has been prepared by Dr. J. S. Nicholson, professor of engineering at the above school, and approved by the joint committee. The contents are of an exceedingly varied character, and include information with regard to speeds and cuts supplied to the committee by the tool makers, procedure in making tests, description of lathe, and method of driving, description of cut and machinery cutting; various results of experiments, endurance trials, as well as the physical, mechanical, and chemical properties of the material operated upon. There are three appendices, the third including the German experiments. There are sixteen plates, besides a list of tables containing results of experiments made with rapid cutting steel tools, as also upon soft and other classes of steel, densities of materials, results of hardness tests, chemical analyses of materials reported upon, &c. The charts are especially valuable.

THE ROYAL SOCIETY.—The Council of the Royal Society have made the following awards of medals for this year:—The Copley medal to Sir William Crookes, F.R.S., for his long-continued researches in spectroscopic chemistry, on electrical and mechanical phenomena in highly rarefied gases, on radio-active phenomena, and other subjects. The Rumford medal to Professor Ernest Rutherford, F.R.S., for his researches on radio-activity, particularly for his discovery of the existence and properties of the gaseous emanations from radio-active bodies. A Royal medal to Professor William Burnside, F.R.S., for his researches in mathematics, particularly in the theory of groups. A Royal medal to Colonel David Bruce, R.A.M.C., F.R.S., for his researches in the pathology of Malta fever, nagana, and sleeping sickness, and especially for his discoveries as regards the exact causes of these diseases. The Davy medal to Professor William Henry Perkin, jun., F.R.S., for his discoveries in organic chemistry. The Darwin medal to Mr. William Bateson, F.R.S., for his contributions to the theory of organic evolution by his researches on variation and heredity. The Sylvester medal to Professor Georg Cantor for his researches in the theories of aggregates and of sets of points of the arithmetic continuum, of transfinite numbers, and Fourier's series. The Hughes medal to Sir Joseph Wilson Swan for his invention of the electric incandescent lamp and various improvements in the practical applications of electricity.

ELECTRICITY AND BAND SAWS.—In view of the ever increasing popularity of electricity as a motive power for wood-working machinery, Messrs. A. Ransome and Co., Limited, of Newark-on-Trent, have adapted their horizontal log-band saws for a direct electric drive when required. This type of machine for log-sawing is now so well known, and is being so universally adopted, that it is unnecessary to give a description of the machine itself. We mention, however, a few details with regard to the new method of driving, which was first adopted by the North-Eastern Railway Company, York, in its railway carriage and wagon works. The front saw-pulley axle is connected direct with the motor by means of a powerful chain. The motor is carried on a platform supported on a strong steel screw provided with a gun-metal nut, which is fitted with a worm wheel. This worm wheel is actuated by a worm fitted to a horizontal shaft, and provided with a chain wheel and chain. A corresponding chain wheel is fitted to the shaft carrying the worms, which actuate the two screws on the machine itself, for raising the saw carriage to suit different thicknesses of cut; and by this means the motor and saw carriage are maintained in their relative positions. The raising gear rests on a strong ball-thrust collar, by means of which the friction is reduced to a minimum. The total width of the floor space occupied by the machine when driven as above described is only 18ft. 6in., and when, in addition to this, it is remembered that neither countershaft nor belting are required under the new conditions, the advantages to be derived from the direct electric drive will be immediately patent to all who have a practical knowledge of machinery.

ELECTRIC LIFT HOISTING EQUIPMENT

THE ALLGEMEINE ELEKTRICITATS GESELLSCHAFT, BERLIN, ENGINEERS



THE PRESS-BUTTON CONTROL OF LIFTS.

THE control of electric lifts by means of the "press button" principle is gradually becoming more common on account of its convenience, certainty of action, and safety. One of the continental firms which has done a good deal of work in this direction is the Allgemeine Elektricitäts Gesellschaft of Berlin. The arrangements made by this firm are claimed to possess a special advantage in the smooth way in which the lift is stopped, the speed being reduced automatically. By reason of this it is further claimed that a greater speed may be attained than formerly. The installation comprises a reversing starter, a controlling apparatus, and a box of press buttons in the cage, another at the entrance of lift at the various floors, the wiring, the pneumatic brake, and a safety cut-out. The most interesting feature of the

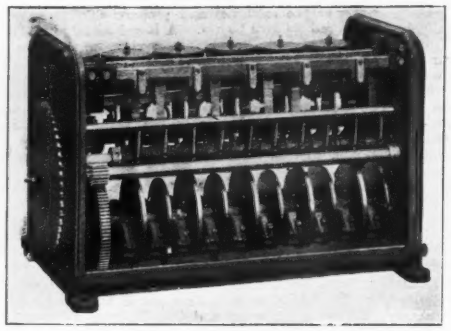


Fig. 1—CONTROL MECHANISM

system is the controlling apparatus. It consists of relays placed on the several floors, reversing switches to reverse the direction of the lift; rheostats, which before stoppages cause the required decrease in speed, and of the safety device which prevents any button being pressed whilst the cage is in motion. When a starting button is pressed, the controlling apparatus is set working. The relay on the floor corresponding to that button is put into communication with the controlling apparatus and receives a current. This closes the circuit of the motor driving the lift and the electro-magnet controlling the reversing switch. After this operation the motor starts up and the lift commences to travel. When the cage has reached a point about 1 m. from the place where it is desired to stop it, the circuit of the motor driving the hoisting drum is broken automatically. The controller is at the same time brought back to the neutral position and the speed is diminished, because before these operations have been performed the necessary connections are made to cause the motor to run at half-speed. When the cage reaches the stopping point the interrupter of the controlling apparatus on that floor immediately opens and breaks the current of the floor relay and of the reversing switch of the starter. The controller in going back to the neutral position automatically puts a brake on the motor and breaks the current of the motor of the pneumatic brake. By this arrangement it is said that shocks at stopping are barely felt. The starter for the return journey of the cage is placed horizontally, and is worked by a powerful electro-magnet. It has two separate barrels. That for starting the motor is actuated by a large electro-magnet. The circuit is made slowly by means of a special winged air damper; the second cylinder, which can be worked in both directions by two small motors, one for each direction, causes the change of direction of the current in the armature, thus bringing about reversal of rotation. In the neutral position, an electric brake is automatically

Fig. 2—REVERSING MECHANISM

applied, and the electric circuit of the magnet for the pneumatic brake is broken, also automatically. The return of the controller to the neutral position when the interruption of the electric current occurs is brought about by means of a spring. The brushes and the segments of the commutator are made of copper, and can be easily renewed. The resistances are all of cast iron. The controlling mechanism comprises relays on the various floors, change-over switches for half speeds, and reversing switches for the two directions of motion, which at the same time serve as cut-outs at the various stopping-places. The apparatus comprises as many relays as there are floors, and an extra relay for safety. The floor relays get their current when the correct button in the cage is pressed; at the same time they close the circuit of the reversing switch and of the starting mechanism down. When the yoke of the relay is pulled by its magnet a secondary circuit is automatically closed, and maintains the yoke. The button, therefore, need only be pressed for an instant. By this action a current is made to traverse the safety relay, which thereupon breaks the return circuit common to the various buttons. By this means the pressing of any other button during the run of the cage has no effect. These relays are placed on one side of the apparatus, and on the other side there are the interrupters. These are worked by excentric discs fixed to a common shaft, which receives its motion through toothed gearing, by means of a chain, from the barrel of the lift. The gearing is such that one revolution of the shaft corresponds to the total lift of the cage. The periphery of the excentrics therefore represents the travel of the lift. There are two excentric discs for each stopping point—one actuates the reversing switch for the direction of motion, which is at the same time a floor interrupter; the other actuates a two-way switch, which controls the speed. All the discs are provided with regulating devices, which are set in correct position by a special key. The button case in the cage contains one button for each floor, a switch for lighting, and a supplementary button for stopping the cage at any desired position. Buttons are also placed near the doors on the different landings to call for the cage. Contacts are provided at the doors to prevent the lift from being set in motion when the doors are open. They are placed at the top of the door, and are worked by a lever, or they can be placed at the lock. The current is brought to the cage by a flexible cable, containing several strands insulated from each other, the number being in proportion to the number of floors the lift has to serve. It also contains the wires for lighting, and is strengthened by a core wire to prevent rupture. The motor actuating the pneumatic brake is used exclusively for that purpose. It is shunt-wound. The air is controlled by a damper, which is regulated by means of a screw, so that the brake can be used at different speeds. The motor for the lift is shunt wound. In order to break the main circuit in case of the failure of the suspension ropes or overrunning of the cage, an interrupting safety lever is used, which is in communication with the lifting mechanism. This device works automatically, and

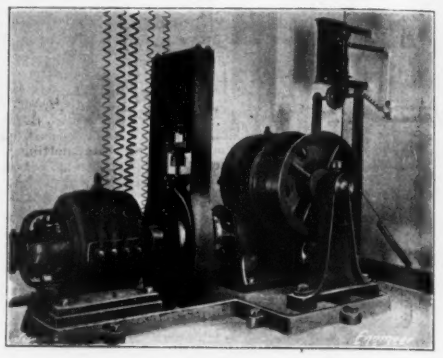


Fig. 3—SMALL LIFT PLANT

controls the electrical hauling gear by a chain transmission; the only extra detail necessary is a cone on the drum shaft.

The button control method has the advantage that it requires no particular training or knowledge on the part of the user, and, consequently, there is no necessity for an attendant. To start the machine all that is required is to press the button corresponding to the floor to which, to ascend or descend, one wants to go. The cage immediately starts, and stops automatically at the proper floor.

In Fig. 3 we give a view of a neat little lift equipment designed by the same firm. The general arrangement and method of working will be quite evident. An especial feature is the large electro-magnet working the brake. This lift is not intended for passengers, but for carrying books and documents, and it is constructed for four stopping places.

KING EDWARD VII. SANATORIUM.—This sanatorium for the treatment of consumptives on the open air principle is being built, as many of our readers will be aware, at Midhurst, Sussex. Special attention has been paid to the equipment, and every care has been taken to have only the most approved appliances, and nowhere is this better illustrated than in the provisions for the warming and hot water supply. At the boiler-house is laid down one central plant consisting of boilers, economisers, pumps, generators, engines, dynamos, &c. From this plant is supplied the power requisite for all purposes throughout the buildings. The general warming is on the "D.G." economic centralised system, with a positive circulation by low-pressure hot water warmed in generators by exhaust steam, so utilising what would otherwise be a waste product. The heating surface throughout the buildings is in the form of radiators, all under control. In addition, for the chapel and dining-hall an alternative system is provided, the floors being heated over their entire area, the heat radiated from them warming the buildings. The floors are solid throughout, so that there is no receptacle for the reception of dust or other contamination. The hot water supply is on the same principle as the general heating, exhaust steam being used in a similar manner. The architect for the work is Mr. H. Percy Adams, F.R.I.B.A., London, and the engineering contractors Messrs. Dargue, Griffiths and Co., Limited, Liverpool and London.

PRIVATE BILLS AND THE BOARD OF TRADE.—In view of the preliminary steps in compliance with Standing Orders of Parliament required to be taken at this period of the year by persons interested in the promotion of Private Bill Legislation for the ensuing session, inquiries have been made of the Board of Trade with the object of learning whether proposals for the authorisation of new "tube" or other railway schemes in or near London should await the report of the Royal Commission on London Traffic, in accordance with the intimation made in the House of Lords on the 6th August, 1903. On that occasion the Lord Chairman of Committees said:—"It is impossible for Parliament to consider any new schemes for new tubes or large railway extensions through London until the Commissioners have reported. I do not, of course, refer to measures dealing with existing lines, alterations of capital, purchases of small portions of land, or matters of that kind." It is, of course, open to promoters to make application to Parliament for Bills in the usual way, and it is possible that Bills may be presented containing proposals of pressing public importance which Parliament might think it right to proceed with at once. But as regards all ordinary proposals for new tubes and large railway extensions the President of the Board of Trade is of opinion that, until the Commissioners have issued their report, and Parliament has had an opportunity of considering its recommendations, Lord Morley's warning to promoters still holds good. He understands that the parliamentary authorities concur in this view.

CAUSES OF EXPLOSIONS IN AIR COMPRESSORS.

In a paper recently read and discussed before the Mechanical Engineers' Association of the Witwatersrand, dealing with the above-mentioned subject, and prepared by Mr. E. Goffe, several important points were touched upon, and considerable advance was made towards the final settlement of the question.

It appears that in the reports of previous discussions on this subject that have taken place in various mining centres, after making due allowance for some other possible contributing causes, such as dirt and the use of unsuitable lubricants, the general conclusion arrived at was that the explosions were due to excessive heat generated within the compressor cylinder, and it was considered that such would not be the case in the use of modern two-stage compressors.

Mr. Goffe, however, was able to cite particulars of two instances, and to vouch for the occurrence of three other cases, and these explosions, five in total, all occurred in the use of two-stage compressors.

In the first instance, there were two compressors working side by side, a horizontal twin-tandem compound steam and two-stage air machine—Walker—having 13in. and 26in. diameter air cylinders, all 48in. stroke, speed 25 revolutions per minute; and a horizontal cross-compound steam and two-stage air machine—Riedler—having 20in. and 34in. diameter steam cylinders, and 20in. and 33in. diameter air cylinders, all 48in. stroke, speed 68 revolutions per minute. Each compressor was jacketed, had an inter-cooler, and delivered air to a common receiver.

While both compressors were running the driver saw a flame burst from the high-pressure air delivery pipe connecting the heads on the Riedler, this flame being followed by dense smoke. Both engines were stopped as quickly as possible, and on examination it was found that the T branch leading away from the cylinder was cracked right round, being practically broken off. The packing was blown out of the joints, and general signs of burning were visible. A lot of deposit was found in the valve chambers and cleared away. No smoke was reported as being delivered to the drills in the mine. This may be accounted for by the fact that on starting up again after repairs it was found that a valve on the air main to the shaft was choked with the same deposit.

Temperatures of the air, &c., at the time were not available, but immediately on resuming running, and when under the same conditions, a temperature of 325 deg. was found in the high-pressure delivery, with air pressure of 75 lb. The cooling water was not obtainable at this mine under 118 deg. Fah. The usual lubrication of cylinder up to the time of explosion was a mixture of one part of valvoline oil to nine parts of soapy water, which was perfectly satisfactory, judging by the condition of the bore of the cylinder and of the valves. The air intake was an opening on the valve chest, protected by coarse wire netting. The Bristol recorder made no indication of any excess of pressure at the moment.

In another case there were three independent compressors working together, delivering into one main leading to a receiver, from whence the supply went to the shaft. The sizes of the compressors were:—Vertical—King Riedler—19in. and 30in. diameter steam cylinders, 20in. and 32in. air cylinders, all 42in. stroke, speed 80 revolutions per minute; vertical triple steam and two-stage air—Vulcan—with 14½in., 23½in., and 35½in. diameter steam cylinders, and 18in., 23in., and 23in. diameter air cylinders, all 35½in. stroke; horizontal cross compound—Ingersoll-Sergeant—with 18in. and 34in. diameter steam cylinders, and 18½in. and 30in. diameter air cylinders. All the cylinders were water-jacketed. The relative position of the compressors was such that the delivery pipes formed a T-shape, with the King Riedler and Ingersoll at either end of the top member, and the Vulcan between them close to the branch which leads to the receiver just outside the engine-house. There were two safety valves on the air pipe, one close to the King Riedler and one close to the Vulcan, as well as one on the receiver outside.

While all three compressors were working at ordinary full speed against a gauge pressure of 68 lb., the driver, who was standing by the King Riedler, saw flames burst from both safety valves, extending up to the roof, this being followed by dense smoke which filled the whole place. A similar flame came from the safety valve on the receiver. He immediately slowed down the engines and no further development occurred. The Bristol recording gauge showed a sudden and momentary rise of pressure to 120 lb. The resulting damage was found to be that all paint and grease was burnt off the outside of the delivery pipe from the King Riedler to the branch of the Vulcan, and thence along to the receiver. The outside of the receiver was burnt in a similar manner, and the mine pipe as far as the collar of the shaft. All the soft packing on the valve stems of the air cylinders of the King Riedler was burnt out, and a charged residue was found afterwards in the valve chambers.

Smoke was reported as having been delivered to the machines in the mine. There were no marks or no evidence of the flame having struck back to either the Vulcan or Ingersoll compressors.

The oil used in these compressors was high-grade, with a flash point of 494 deg. Fah. The quantity used by the three—that is, for air cylinders alone—is one gallon per twenty-four hours. No soft soap or soapy water was ever used. The valves were taken out and examined regularly fortnightly and forks adjusted. The temperatures of the air at the time of the explosion were not known, but from observations taken after, at times of greatest output, the maximum observed was 290 deg. Fah. in the high-pressure delivery, with 264 deg. Fah. in the low-pressure delivery, both taken close to the delivery valves.

The first stage air, by passing through the intercooler, was cooled down to a temperature of between 80 deg. Fah. and 90 deg. Fah. The jacket water was ample and always cold, the difference between the inlet and outlet being only just sensible to the touch. The air intake to the King Riedler was entirely from the engine-room, was fairly high up, and ranged in temperature from 90 deg. Fah. to 102 deg. Fah.

The author of the paper went on to state that there must be two factors present before an explosion or flashing can take place. First, an explosive mixture; secondly, a temperature sufficiently high to explode this mixture. The oil used was generally the first thing blamed when accident occurs. If an ordinary lubricating mixture were in use this might be justifiable, but a great deal depends on the conditions under which the compressor is run, and the instance was advanced of one compressor in which it was the custom to use good engine oil—two drops per minute per cylinder—and with which no trouble has ever been experienced. This compressor, however, was a slow running one, about 40 revolutions usual speed, only worked ten hours per day, had good cooling water, and delivered its air at about 120 deg. Fah., the air pressure being 70 lb. The usual arrangement of the air intake of compressors, rendering a supply of pure, cool air an impossibility, was then attacked, and it was pointed out that the recesses of the valve chambers, ports, air pipes, intercooler and receiver, allowed for the accumulation of this dust, it making with the lubricant a pasty, gummy mass, which offered further inducement to segregation of particles.

With reference to the second condition necessary for flashing—the temperature attained—experiments in other places were quoted showing that leaks through the pistons and valves of air cylinders were able to produce much higher—in fact, dangerously higher—temperatures than those calculated upon in the ordinary way. With two-stage compressors this danger was reduced, but the effect of such leaks on the ultimate temperatures must be very appreciable. In the two cases of explosion previously cited, the oil used was certainly of the best quality, and the temperatures observed in usual running had not hitherto been considered dangerous. In the other cases vouched for the conditions of working and the effects observed were very similar. The oil used in one instance was tested and the flash point determined as 550 deg. Fah.

A sample of the deposit that was removed from the valve chambers after one explosion was submitted for analysis to Mr. G. Watson Gray, F.I.C., of Liverpool, and the result obtained was as follows:—

Mineral oil	13·70
Vegetable oil (altered)	13·10
Carbonaceous and other matter	52·40
Sandy matter	9·00
Oxide of iron	5·92
Alumina	2·08
Lime	0·78
Magnesia	0·94
Oxide of copper	1·70
Loss, &c.	0·78
	100·00

The analyst also reported that a very large quantity of dust containing coal had been drawn into the cylinders, and that this had got incorporated with the oils. The experiments of Professor Bedson were cited, these showing that coal dust will ignite at a temperature of 291 deg. Fah. when heated in a current of air at atmospheric pressure; that the increase of the pressure to 60 lb. per square inch does not materially alter the temperature of ignition, but that a much more intense heat is produced by the combustion at the higher pressure.

When it is considered that precautions are not usually taken to ensure a supply of pure air to the compressor intake, and, as it is known that temperatures of about 300 deg. Fah. exist in the region of the high-pressure delivery passages, it is not at all surprising that explosions frequently occur, and it is evident that to prevent such accidents, which may, of course, lead to fatal poisoning effects among the underground workers, as well as jeopardising lives and property in the engine-room, the following reasonable precautions should be taken:—

(1) The inlets of air compressors should be connected by closed tubes to the outside of the engine-house, to the most shaded and coolest side by preference. These tubes should suck from a chamber containing air filtered and cooled as far as possible.

(2) The lubricating oil should be of first quality, and high flash point.

(3) All internal passages, recesses, and pockets in the valve chambers and delivery pipes, in which surplus oil and dirt may accumulate, should be made accessible for examination, and frequently cleaned.

In the discussion the design of the valves of certain compressors was adversely criticised as not affording adequate free opening and unduly throttling the air.

A wish was also generally expressed for a sensitive recording thermometer capable of registering the abnormal rises of temperature that are believed to occur, and with great suddenness. For instance, it was considered that a rise in temperature of perhaps 100 deg. might possibly take place in an interval of time as small as 0·1 of a second.

It has not been the practice to fit after-coolers to compressors on the Rand, and it is doubtful if these would have any success in the way of preventing explosions, considering it as being probable that the flashing takes place in the immediate vicinity of the high-pressure delivery.

AWARDS TO BRITISH EXHIBITORS AT ST. LOUIS.

We have received from the offices of the Royal Commission for the St. Louis Exhibition a full list of the awards made to British exhibitors. We give below a list of those who were successful with exhibits dealing with engineering and allied subjects.

DEPARTMENT OF LIBERAL ARTS.

Bronze medal.—The Survey of India (Simla).

Group 18.—Maps and Apparatus for Geography.

Grand prize.—Board of Agriculture and Fisheries, Ordnance Survey of Great Britain and Ireland, Royal Geographical Society, Admiralty (Hydrographical Department), The Survey of India, Palestine Exploration Fund, and J. Bartholomew and Co.

Gold medal.—Edward Stanford, and W. and A. K. Johnston, Limited.

Bronze medal.—Newton and Co.

AWARDS TO COLLABORATORS.

Gold medal.—George Armstrong (Palestine Exploration Fund).
Silver medal.—John Bolton (Edward Stanford); Messrs. Cary, Porter, Limited (Royal Geographical Society).

Group 19.—Instruments of Precision.

Grand prize.—Sir Howard Grubb, F.R.S.; The Cambridge Scientific Instrument Company; The Royal Mint.

Gold medal.—Thomas Thorp; A. Hilger; W. F. Stanley and Co., Limited; Newton and Co.

Silver medal.—John J. Griffin and Sons, Limited; The Pulsometer Engineering Company, Limited; Atchison and Co.

Bronze medal.—C. and E. Layton, and John Davis and Sons, Limited.

AWARDS TO COLLABORATORS.

Gold medal.—W. J. Hocking (The Royal Mint).
Bronze medal.—Henry Fleuss (The Pulsometer Engineering Company, Limited.)

Group 23.—Chemical and Pharmaceutical Arts.

Grand prize.—Low Temperature Research Exhibit of the British Royal Commission; British Cyanides Company, Limited; Burroughs, Wellcome and Co.; Edward Cook and Co., Limited; Doulton and Co., Limited; Joseph Crosfield and Sons, Limited; J. C. and J. Field, Limited; Evans Sons, Lescher, and Webb, Limited; Gas Light and Coke Company; Hopkins and Williams, Limited; Howards and Sons, Limited; Levinstein, Limited; Nobels Explosives Company, Limited, and the Birmingham Metal and Munitions Company; Price's Patent Candle Company, Limited; Professor Sir William Ramsay, K.C.B., D.Sc., LL.D., F.R.S.; United Alkali Company, Limited; Peter Spence and Sons, Limited.

Gold medal.—Allen and Hanburys, Limited; Stafford Allen and Sons, Limited; Anglo-Sicilian Sulphur Company, Limited; Baird and Tatlock (London), Limited; Brooke, Simpson and Spiller, Limited; Brunner, Mond and Co., Limited; Burmah Oil Company, Limited; The Cassel Gold Extracting Company, Limited; The Kastner-Kellner Alkali Company, Limited; Chance and Hunt, Limited; Spencer Chapman and Messel, Limited; Corbyn, Stacey and Co., Limited; John J. Griffin and Sons, Limited; Hemingway and Co. and Hemingway's London Purple Company, Limited; McDougall Brothers; May and Baker, Limited; Dr. Ludwig Mond, F.R.S.; T. Morson and Son; The Owens College; James Pain and Sons; Royal College of Science, London; South Metropolitan Gas Company; Townson and Mercer; Thomas Tyrer and Co., Limited; John and James White; Wood and Bedford.

Silver medal.—Assam Oil Company, Limited; Lewis Berger and Sons, Limited; A. Boake, Roberts and Co.; Walter Carson and Sons; J. M. Collett and Co.; R. and J. Garroway; The Glasgow and West of Scotland Technical College; Professor W. N. Hartley, D.Sc., F.R.S.; F. Kendall and Son, Limited; John Bennet Lawes and Co., Limited; Joseph W. Lovibond; Dr. Allen Macfadyen; William Martindale; The Mond Nickel Company, Limited; Morris, Little and Son, Limited; B. E. R. Newlands, F.I.C., F.C.S.; Newton, Chambers and Co., Limited; Parkin, Ness and Co.; W. Pearce and Sons, Limited; Sharon Chemical Company, Limited; Sheppey Glue and Chemical Works, Limited; J. W. Swan, F.R.S., and J. A. Kendall; William Warren (Hooper and Co.).

Bronze medal.—J. B. Aitken; P. and J. Arnold; John Austen; E. C. C. Baly; Battley and Watts; F. W. Berk and Co., Limited; The Bone Phosphate and Chemical Company, Limited; Cerebos (1903), Limited; George Clark and Son, Limited; Cornwall Arsenic Company; H. C. Fairlie and Co.; Daniel Davison; The Grove Chemical Company, Limited; W. H. Francis; W. J. Fraser and Co.; F. C. Hills and Co., Kemball, Bishop and Co., Limited; The Society of Apothecaries of London; Stone and Tinson; John and E. Sturge; Alfred White and Sons.

AWARDS TO COLLABORATORS.

Gold medal.—Professor Sir James Dewar, M.A., LL.D., D.Sc. F.R.S. (Low Temperature Research Exhibit); T. Wilton (The Gas Light and Coke Company); Dr. Andrew Ross Garrick (The United Alkali Company, Limited).

Silver medal.—J. E. Petavel (Low Temperature Research Exhibit); Dr. Rudolf Messel (Spencer, Chapman and Messel, Limited); Julius Leukowitch, Ph.D.

Bronze medal.—Dr. Carl Langer (The Mond Nickel Company, Limited), C. T. Tyrer (Thomas Tyrer and Company, Limited), Hugh Ramage (Professor W. N. Hartley).

Group 26.—Models and Plans of Public Works.

Grand prize.—Trinity House; The Commissioners of Irish Lights; William Simons and Co., Limited; War-office; Ransomes and Rapier, Limited; John Aird and Co.; James Mansergh and Sons; The Public Works Department of India; The Trustees of the Clyde Navigation; The River Wear Commissioners; The Dublin Port and Docks Board; The Mersey Docks and Harbour Board.

Gold medal.—Grand Junction Canal Company; Westminster City Council; The London County Council; Stothert and Pitt, Limited, Engineers; Corporation of the City of Glasgow; County Councils of Middlesex and Surrey; Manchester Corporation (Rivers Department); London and South-Western Railway Company; Bombay Port Trust.

Silver medal.—Hove Corporation; Scarborough Corporation; Birmingham Corporation; The Commissioners of the Harbour and Docks of Leith; London and India Docks Company.

Bronze medal.—Barry Railway Company.

AWARDS TO COLLABORATORS.

Grand prize.—W. M. Alston (The Trustees of the Clyde Navigation); H. Hay Wake, M.I.C.E. (River Wear Commissioners); B. B. Stoney (Dublin Port and Docks Board); A. G. Lyster (Mersey Docks and Harbour Board.

Gold medal.—George Idle (The Commissioners of Irish Lights); Barnabas James Thomas (Grand Junction Canal Company); J. F. Griffith (The Dublin Port and Docks Board); Maurice Fitzmaurice (The London County Council); P. Glynn Messent, M.I.C.E. (Bombay Port Trust.)

Silver medal.—Peter Whyte (The Commissioners for the Harbour and Docks of Leith); Charles William Scott (The Commissioners of Irish Lights); Edwin Thomas Beard, A.M.I.C.E. (Scarborough Corporation); J. W. Williams (London and South-Western Railway Company.)

Bronze medal.—John Price (Birmingham Corporation.)

Group 27.—Architectural Engineering.

Grand prize.—Ernest George and Yeates.
Gold medal.—Robinson Hainsworth.
Silver medal.—Liverpool Corporation.

DEPARTMENT OF MANUFACTURES.

Group 28.—Stationery.

Gold medal.—P. and J. Arnold.

Group 29.—Cutlery.

Silver medal.—J. R. Gaunt and Son, Limited.
Bronze medal.—F. P. Bhumgara and Co.

Group 30.—Silversmiths' and Goldsmiths' Ware.

Grand prize.—F. P. Bhumgara and Co.
Gold medal.—John Wells.

Group 31.—Jewellery.

Silver medal.—F. P. Bhumgara and Co.

Group 46.—Plumbing and Sanitary Materials.

Gold medal.—Waring and Gillow, Limited.
Silver medal.—Wm. Bradley.

Group 47.—Glass and Crystal.

Gold medal.—John Moncrieff. The Cloisonne Mosaic Company.

AWARDS TO COLLABORATORS.

Bronze medal.—Joseph Duff (John Moncrieff).

Group 48.—Apparatus for Heating and Ventilation.

Bronze medal.—John Sim.

Group 50.—Textiles.

Grand prize.—Platt Brothers and Co., Limited.
Gold medal.—Wilson Brothers Bobbin Company, Limited. Wilson and Co., Barnsley, Limited.

AWARDS TO COLLABORATORS.

Bronze medal.—A. Greenwood (Wilson Brothers Bobbin Company, Limited), John Binns (Wilson Brothers Bobbin Company, Limited), Barton Greenwood (Wilson Brothers Bobbin Company, Limited), John Young (Wilson Brothers Bobbin Company, Limited), Frank Helliwell (Wilson Brothers Bobbin Company, Limited).

Group 51.—Plant and Processes used in Textiles.

Gold medal.—The Singer Manufacturing Company.

Group 52.—Plant and Processes for Finishing Textiles.

Gold medal.—Danl. Lee and Co.; William Liddell and Co., Limited; John S. Brown and Sons.

Group 53.—Plant and Processes for Making Wearing Apparel.

Gold medal.—The Singer Manufacturing Company.

AWARD TO COLLABORATOR.

Gold medal.—L. H. Smith (The Singer Manufacturing Company.)

Group 54.—Threads and Fabrics of Cotton.

Gold medal.—Danl. Lee and Co.; Turnbull and Stockdale, Limited.

Group 55.—Threads and Fabrics of Flax, Hemp, &c.

Grand prize.—John S. Brown and Sons; Wm. Liddell and Co., Limited.

Gold medal.—Gourepore Company, Limited; Steel and Co, Dunfermline, Limited; Danl. Lee and Co.; Turnbull and Stockdale, Limited.

DEPARTMENT OF MACHINERY.

Group 62.—Steam Engines.

Grand prize.—John Fowler and Co. (Leeds), Limited.
Silver medal.—John Moncrieff.

Group 64.—General Machinery.

Grand prize.—Davidson and Co., Limited.
Silver medal.—Joseph Baker and Sons, Limited; Price's Patent Candle Company, Limited.

Group 65.—Machine Tools.

Silver medal.—Peter Wright and Sons.

DEPARTMENT OF ELECTRICITY.

Group 68.—*Electro-Chemistry.*

Gold medal.—United Alkali Company, Limited.
Silver medal.—Sherard Cowper-Coles and Co., Limited.

AWARDS TO COLLABORATORS.

Silver medal.—Dr. Andrew Ross Garrick (United Alkali Company, Limited).

Group 69.—*Electric Lighting.*

Gold medal.—The Consolidated Electrical Company, Limited; Geo. Trollope and Sons.

Group 70.—*Telegraphy and Telephony.*

Grand prize.—General Post Office, London.
Gold medal.—The India-rubber, Gutta-percha and Telegraph Works Company, Limited; Muirhead and Company.

Group 71.—*Various Applications of Electricity.*

Grand prize.—The Cambridge Scientific Instrument Company, Limited; Nalder Brothers and Co.
Gold medal.—Nalder Brothers and Thompson, Limited; Crompton and Co., Limited; Everett, Edgcumbe and Co.; Robert W. Paul; Newton and Co.; Alfred C. Cossor; Elliott Brothers; Kelvin and James White, Limited; The Synchronome Company.
Silver medal.—F. Darton and Co.

AWARDS TO COLLABORATORS.

Grand prize.—Lord Kelvin (for important contributions to Electrical Engineering).
Gold medal.—Hugh Langbourne Callendar, F.R.S. (Cambridge Scientific Instrument Company, Limited); William du Bois Duddell, Wh.Sc. (Cambridge Scientific Instrument Company, Limited).
Silver medal.—Robert Stewart Whipple (Cambridge Scientific Instrument Company, Limited); A. C. Heap (Elliott Bros.).

DEPARTMENT OF TRANSPORTATION.

Group 72.—*Carriages and Wheelwrights' Work.*

Bronze medal.—H. C. Slingsby; The "Plywell" Pole Appliance Company.

Group 74.—*Railways.*

Gold medal.—The London and North-Western Railway Company; Public Works Department (Railways), India.
Silver medal.—The East Coast Railways; The British South Africa Company (Rhodesia); North-Eastern Railway; F. B. Behr.
Bronze medal.—Bengal North-Western Railway; John Jones.

AWARD TO COLLABORATOR.

Bronze medal.—Alfred Bromwich (The British South Africa Company, Rhodesia).

Group 75.—*Plant and Material for Mercantile Marine.*

Grand prize.—Cunard Steamship Company, Limited.
Gold medal.—The Anchor Line (Henderson Brothers), Limited; Oceanic Steam Navigation Company, Limited; City of Dublin Steam Packet Company; James Pain and Sons; Swan, Hunter and Wigham Richardson, Limited.
Silver medal.—Pacific Steam Navigation Company; Alfred Jeffery and Co.; Smith's Dock Company, Limited; Axel Welin, A.I.N.A.; Thos. Cook and Son.

DEPARTMENT OF TRANSPORTATION.

Group 76.—*Plant and Material for Naval Services.*

Bronze medal.—Birmingham Metal and Munitions Company.

Group 77.—*Aërial Navigation.*

Silver medal.—The Industrial Engineering Company.

DEPARTMENT OF AGRICULTURE.

Group 78.—*Farm Equipment.*

Bronze Medal.—Parkin, Ness and Co.

Group 79.—*Agricultural Implements.*

Bronze medal.—Jervis Potato Planter Company.

Group 80.—*Fertilizers.*

Gold medal.—The Aberdeen Comb Works Company, Limited; Sheppey Glue and Chemical Works, Limited.
Silver medal.—The Grove Chemical Company, Limited.

Group 82.—*Appliances for Agricultural Industries.*

Silver medal.—Morris, Little and Son, Limited.

DEPARTMENT OF FORESTRY.

Group 112.—*Appliances and Processes used in Forestry.*

Gold Medal.—Forest Department, India.
Silver medal.—The Royal Scottish Arboricultural Society; C. Richardson.

Group 114.—*Appliances for Gathering Wild Crops.*

Gold medal.—The Wellcome Chemical Research Laboratories.

DEPARTMENT OF MINES AND METALLURGY.

Group 115.—*Working of Mines.*

Gold medal.—Robinson Hainsworth; John Davis and Sons.

Group 116.—*Ores and Minerals.*

Grand prize.—Home-office (Mining Department); Department of Agriculture and Technical Instruction for Ireland.
Gold medal.—The Harehope Mining and Quarrying Company, Limited; Verde Antico Marble Company, Limited; P. Macfadyen and Co.; Johnson and Sons, Limited.
Silver medal.—The British South Africa Company (Rhodesia); Edgar Allen and Co., Limited.

AWARDS TO COLLABORATORS.

Gold medal.—William West Ware (Home-office); Griffiths John Williams (Home-office).
Silver medal.—J. C. Baron (Home-office).

Group 117.—*Geological Maps and Plans of Mines.*

Grand prize.—Geological Survey of India.
Silver medal.—Herbert W. Hughes, F.G.S.

Group 118.—*Metallurgy.*

Grand prize.—Birmingham Metal and Munitions Company. The Monk Bridge Iron and Steel Company, Limited.
Gold medal.—Sherard Cowper-Coles and Co., Limited; The Lilleshall Company, Limited; The Farnley Iron Company, Limited.
Silver medal.—The Anglo-French Nickel Company, Limited; Sheepbridge Coal and Iron Company, Limited; United Alkal Company, Limited.
Bronze medal.—Joseph W. Lovibond.

Group 119.—*Mining Literature.*

Grand prize.—The Iron and Steel Institute; The Geological Survey of India.
Gold medal.—The Institution of Mining Engineers.

AWARDS TO COLLABORATORS.

Gold medal.—Bennett H. Brough (The Iron and Steel Institute).
Silver medal.—M. Walter Brown (The Institution of Mining Engineers).

THE DEVELOPMENT AND USE OF HIGH-SPEED TOOL STEEL.*

By J. M. GLEDHILL.

IT would doubtless have been felt by many but a few years back that there was little left to be said on the subject of crucible tool steel, and that something akin to finality had been arrived at in its manufacture and general treatment. Probably such feeling was justifiable when it is remembered that the making of steel in crucibles is by far the oldest method known, dating back from time immemorial, it being, indeed, impossible accurately to trace its origin and earliest development, but it seems certain that carbon steel was made and used thousands of years ago for cutting tools.

A very important advance was made thirty or forty years ago, when "Mushet," or self-hardened steel, was introduced. This was the valuable invention of Robert Mushet, who, after a long series of experiments, made whilst he was manager of the Titanic Steel Company, succeeded in producing a tungsten steel, and its introduction was a great advancement on the cutting powers of ordinary crucible steel, and for many years "Mushet" steel held a foremost place amongst tool steels.

It is now to America, however, that all honour must be given for the next great step in having "set the pace" and led the way in the present remarkable advancement in tool steel, and the author would here like to record that the greatest credit is due to Messrs. Taylor and White, who, at the Bethlehem Steel Works of America, initiated high-speed cutting, and at the exhibit of their firm in Paris some few years back, what were then considered to be astonishing results in speeds of cutting steel were publicly demonstrated. Since then still greater developments have been made, and with increased experience in its manufacture, treatment, and application in our workshops, results in cutting powers far beyond expectation have been attained. With high-speed tools, steel can now be turned and machined at a rate up to 500ft. per minute, and cast iron drilled at 25in. per minute. It must be admitted that this is an astonishing advancement on the cutting speeds of 30ft: to 50ft. per minute with ordinary crucible steel.

In the manufacture and production of high-speed steels—the best being made by the crucible process—the author has proved conclusively that the most satisfactory results are obtainable only by using the purest qualities of Swedish or Dannemora irons, which, on account of their freedom from impurities, render them most suitable for producing tool steels that will best retain their cutting edges, and also the use of the highest qualities of the various alloys and other ingredients employed in the composition of the steel.

The high-speed steels of the present day are combinations of iron and carbon with (1) tungsten and chromium; (2) molybdenum and chromium; and (3) tungsten, molybdenum, and chromiumr These present many interesting varieties and offer a wide field for research. The author said that he had made a large number of experiments to ascertain comparative cutting powers of steels produced by varying proportions of these elements, and he gave an interesting summary of the influence of steel on carbon, chromium, tungsten, molybdenum, silicon, &c.

The annealing of high-speed steel is best carried out in muffle furnaces designed for heating by radiation only, a temperature of 1400 deg. Fah. being maintained from twelve to eighteen hours, according to the section of the bars of steel dealt with. In preparing high-speed steel ready for use the process may be divided principally into three stages—forging, hardening, and grinding.

In heating a bar of high-speed steel preparatory to forging—which heating is best done in a clear coke fire—it is essential that the bar be heated thoroughly and uniformly, so as to ensure that the heat has penetrated to the centre of the bar, for if the bar be not uniformly heated, leaving the centre comparatively cold and stiff, whilst the outside is hot, the steel will not draw or spread out equally, and cracking will probably result. A wise rule in heating is to "hasten slowly." The temperature for hardening high-speed steel varies somewhat according to the class of tool being dealt with. When hardening turning, planing, or slotting tools, and others of similar class, the point or nose of tool only should be gradually raised to a white melting heat, though not necessarily melted; but even should the point of the tool become to a more or less extent fused or melted, no harm is done. The tool should then be immediately placed in an air blast and cooled down, after which it only requires grinding, and is then ready for use.

In hardening where oil cooling is used the tools should be first raised to a white heat, but without melting, and then cooled down either by air blast or in the open to a bright red heat, say, 1700 deg. Fah., when they should be instantly plunged into a bath of rape or whale oil, or a mixture of both.

Referring to the question of grinding tools, nothing has yet been found so good for high-speed steels as the wet sandstone, and the tools ground thereon by hand-pressure; but where it is desired to use emery wheels it is better to roughly grind the tools to shape on a dry emery wheel or dry stone before hardening.

With regard to the hardening and tempering of specially formed tools of high-speed steel, such as milling and gear cutters, twist drills, taps, screwing dies, reamers, and other tools that do not permit of being ground to shape after hardening, and where any melting or fusing of the cutting edges must be prevented, the method of hardening is as follows:—A specially arranged muffle furnace heated by gas or oil is employed, and consists of two chambers lined with fire-clay, the gas and air entering through a series of burners at the back of the furnace, and so under control that a temperature up to 2200 deg. Fah. may be steadily maintained in the lower chamber, whilst the upper chamber is kept at a much lower temperature. Before placing the cutters in the furnace it is advisable to fill up the hole and keyways with common fire-clay to protect them. The mode of procedure is now as follows: The cutters are first placed upon the top of the furnace until they are warmed through, after which they are placed in the upper chamber and thoroughly and uniformly heated to a temperature of about 1500 deg. Fah., or, say, a medium red heat, when they are transferred into the lower chamber and allowed to remain therein until the cutter attains the same heat as the furnace itself, viz., about 2200 deg. Fah., and the cutting edges become a bright yellow heat, having an appearance of a glazed or greasy surface. The cutter should then be withdrawn whilst the edges are sharp and uninjured, and revolved before an air blast until the red heat has passed away, and then, whilst the cutter is still warm—that is, just permitting of its being handled—it should be plunged into a bath of tallow at about 200 deg. Fah., and the temperature of the tallow bath then raised to about 520 deg. Fah., on the attainment of which the cutter should be immediately withdrawn and plunged in cold oil.

Of course, there are various other ways of tempering, a good method being by means of a specially arranged gas and air stove into which the articles to be tempered are placed, and the stove then heated up to a temperature of from 500 deg. Fah. to 600 deg. Fah., when the gas is shut off and the furnace with its contents allowed to slowly cool down.

Another method of heating tools is by electrical means, and by which very regular and rapid heating is obtained, and where electric current is available, the system of electric heating is quick, reliable, and economical, and a brief description of this kind of heating may be of interest. The method of heating by electric means is then described in the paper by means of illustrations.

Tempering.—Electricity is also a very efficient and accurate means of tempering such forms of tools as milling, gear, hobbing, and other similar cutters, also large hollow taps, hollow reamers, and all other hollow tools made of high-speed steel, where it is required to have the outside or cutting portion hard, and the interior soft and tenacious, so as to be in the best condition to resist the great stresses put upon the tool by the resistance of the metal being cut, and which stresses tend to cause disruption of the cutter if the hardening extends too deep.

Uses.—Having touched upon the development and thermal treatment of high-speed steel, it will now be opportune to refer to its practical use, and to some of the most recent work done with it. It is sometimes contended that on the whole not much advantage or economy results from using high-speed steel, but it is easy to prove very greatly to the contrary, and the author proposes to give some figures and facts as to its use and advantage, not only by knowledge gained from results of his own firm, but also from information supplied by many important engineering establishments as to their present workshop practice, and for which he is indebted. That great economy is effected is beyond all doubt, from whichever point of view the question is looked at; for it is not only rapidity of cutting that counts, but the output of machines is correspondingly increased, so that a greater production is obtained from a given installation than was possible when cutting at low speeds with the old tool steel, and the work is naturally produced at a correspondingly lower cost, and of course it follows from this that in laying down new plant and machines the introduction and use of high-speed steel would have considerable influence in reducing expenditure on capital account. It has also been proved that high-speed cutting is economical from a mechanical standpoint, and that a given horse-power will remove a greater quantity of metal at a high speed than at a low speed, for although more power is naturally required to take off metal at a high than at a low speed—by reason of the increased work done—the increase of that power is by no means in proportion to the large extra amount of work done by the high-speed cutting, for the frictional and other losses do not increase in anything like the same ratio as a high-cutting speed is to a low-cutting speed.

Again, as regards economy, there is not only a saving effected on he actual mach ine work, but since the advent of high-speed cutting, it is now possible, in many instances, to produce finished articles from plain rolled bars, instead of following the old practice of first making expensive forgings and afterwards finishing them in the machine. By this practice not only is the entire cost of forging abolished, but the machining on the rolled bar can be carried out much quicker and cheaper in suitably arranged machines, quicker even than the machining of a forging can be done.

One phase of milling, in which cutters made from high-speed steel will play an even more important part than at the present time, will be that of gear and similar cutting, it now being possible to make formed backed-off cutters of high-speed steel for all purposes.

Again, rapid cutting with planing tools has also developed extensively, the old cutting speeds of 15ft. to 25ft. per minute being now replaced by those of 50ft. to 60ft. per minute, and in some cases even as high as 80ft. per minute; and for the same reasons, as already described in lathe turning, the power absorbed does not increase in anything like the same proportion to the extra amount of work done, so that the wear and tear on the machine is not materially increased.

It was for some time not thought possible to plane at such high speeds on account of the tools coming into contact suddenly with the job and running risks of snapping off through shock; but where high-speed steel of proper quality is used this difficulty is overcome, and a good example or two of rapid planing may be quoted. Using a 7ft. planing machine, with two tools, operating on forged steel of medium quality, the cutting speed, depth of cut, and feed of each tool is respectively 54ft., ¼in., and ⅛in., the speed of reverse being 160ft. per minute.

Another striking example of high-speed planing on a large cast iron turbine body was: Cutting speed, 36ft. per minute; depth of cut, 1·25in.; and feed, seven cuts per inch, the tool cutting for ten hours without necessitating grinding. Two tools were cutting, each taking a cut as described, the size of the planer being 14ft. by 14ft. by 30ft.

Objections have been made against high-speed steel on the grounds of its being brittle, but this is not the case where the steel has been properly annealed and the hardening confined to the cutting area, and sufficient support given to the tools when fixed in the machine.

Perhaps one of the most unlooked-for developments in the use of high-speed steel has been the manufacture from it of twist drills, and it would be safe to say that in no other sphere has the new steel justified itself to a greater extent than in the operations of drilling and boring, as its powers in that respect have revolutionised completely modern workshop practice. It is now possible in many cases to drill holes through stacks of thin steel plates as quickly and economically as by punching them, thus avoiding the consequent liability to distress the material due to punching action.

As a comparison of the superiority of high-speed over ordinary drills, an instructive result was obtained when drilling forged steel gun-cradles of 5in. thickness, and which steel is of a very tough nature. An ordinary twist drill was first tried, and failed after drilling eight holes, the end being completely fused, but a high-speed drill afterwards drilled 124 holes without suffering any injury whatever. The drills were 2in. diameter, running at 80 revolutions per minute, and each hole was drilled in six minutes, this being the full power of the machine. A further illustration of the economy resulting from the use of high-speed twist drills may be gathered from the fact that the author's firm in several instances reduced the cost of drilling per 100 holes by over 60 per cent., without even altering the machines in any way, except by speeding them up. On cast iron quite good results are obtained. Equally satisfactory results are obtained from flat drills and other forms of boring tools made of high-speed steel for use in boring large holes out of solid bars, shafts, forgings, &c., the author's firm daily using drills of this type up to 12in. diameter, and boring holes up to 50ft. long.

Finishing.—A considerable amount of doubt has been thrown from time to time on the inability to take finishing cuts with high-speed steel, and in the early stages of its development this contention was to a large extent justified, but experience and practice has brought the steel into line, and rendered it possible to obtain an excellent finish at high speeds with tools suitably formed and properly arranged in the machines. Some very good examples of finished bright work at high speeds were exhibited on the table, and which have been mostly made in semi-automatic machines, high-speed steel being used and one cut only taken, and it will be seen on examination that the surface finish is most excellent. This finishing quality of high-speed steel is especially advantageous for tools used in automatic and capstan lathes, because it enables the work to be produced so very much more rapidly, and also on account of the great resistance of the steel to wearing action greater accuracy is ensured. As regards the quality of retaining a sharp edge, high-speed steel makes excellent razors, and will long retain without sharpening an extremely keen cutting edge.

In concluding this paper the author added that it cannot be denied that the question of high-speed steel is one of vast importance to all manufacturing countries, for if they are to hold their position in the world's competition they will be compelled to study the use and advantages to be derived from its adoption, and, in addition, to bring up their machinery into the most modern and efficient form for obtaining the utmost producing capacities. The powers of the cutting steel and the machine should be as nearly reciprocal as possible, for, given those conditions, manufacturers place themselves in the most favourable position for the rapid and economical turn out of their products, and for best meeting their rivals in the open field of competition; and, lastly, notwithstanding the wonderful results obtained with the new cutting steel, and developed comparatively so rapidly, nothing approaching finality must be admitted by the steel maker, but incessant diligence, experiment, and research to discover still more the best combinations of Nature's metals should be his constant aim, and in

* Iron and Steel Institute.

the doing of which not only is there much pleasure derivable to himself, but, in addition, there is the benefit it is possible to render to the whole world.

The paper was accompanied by numerous appendices, illustrations, &c.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE engineering trades continue active, and prospects for the remainder of the winter are good. There was a more cheerful tone in all departments on 'Change in Birmingham on Thursday. Several good bargains were concluded. The position has grown decidedly better during the past few weeks. Sheets, singles, are now quoted £6 12s. 6d. to £6 15s.; doubles, £6 15s. to £6 17s. 6d.; and trebles, £7 7s. 6d. to £7 10s. The continued upward movement of spelter, combined with a sustained oversea demand for the finished product, causes the quotation for galvanised corrugated sheets, doubles, to be maintained at £10 5s. to £10 10s., f.o.b., Liverpool. Satisfaction is finding expression at the circumstance that British exports of galvanised corrugated sheets to all countries for the first ten months of this year are an improvement in quantity of a little over 5 per cent. over the corresponding period of last year, they having reached 312,384 tons, which is better than twelve months ago by 15,946 tons. The chief increase has been in the exports to India, which have reached 85,099 tons for the ten months. This is better than a year ago by 31,046 tons, or over 57 per cent. There has also been a great advance in the orders from the Argentine Republic so far this year compared with last year, the progress having been from 27,029 tons to 40,090 tons, or over 48 per cent. There have also been increases in the demand from Australia and New Zealand, the shipments to Australia having grown from 38,394 tons to 45,781 tons; and to New Zealand, from 12,435 tons to 15,336 tons. These indications of progress in the oversea trade have caused much satisfaction among members of the Midland Galvanised Iron Trade Association. In the bar iron trade the contracts held for merchant qualities of unmarked bars are sufficient to afford full employment for some time to come. Marked bars are quoted £8, second grade £6, and common unmarked £5 15s. to £6. North Staffordshire bars are £6 5s. to £6 10s. The demand for best bars keeps up well for forging purposes for Admiralty and railway services, and the quotation is maintained. Gas strip is quoted £5 16s. 6d. to £6, with a better demand than recently, and hoop iron is £6 12s. 6d. to £6 15s.

In the steel trade progress is being made at the works both of the Earl of Dudley and of Sir Alfred Hickman, Limited, in experimental work, with the view to the lessening of costs of production. Sir Alfred Hickman has just increased his metallurgy prize at the Wolverhampton Municipal Science and Technical School from £2 2s. per year to £5 per year, and has also given a donation of £20 towards the establishmeut of a student's library.

An interesting paper was read recently before the Birmingham Association of Mechanical Engineers, by Mr. W. Bardill, managing director of the Wantage Engineering Company, entitled "Engineering Works Policy and Modern Competition." There are, he said, pessimists and optimists. Sensible men, however, would find a *via media* between those extremists. There were at present in this country engineering concerns which were not only holding their own, but paying good dividends. Whilst there was no real cause to bemoan the volume of trade, which, of course, might be better, engineers complained of the cutting of prices, which made it difficult to earn a profit; in fact, many great works often took orders which could not possibly pay. It was an easy matter for a factory to be full of work, the men even working overtime, and yet at the end of the year for the ledger to show a balance on the wrong side. Competition, feverish cutting of prices, said Mr. Bardill, was the rule of the trade. Cheap labour was introduced to turn the balance, but generally speaking cheap labour was very expensive. One good mechanic at 38s. per week was worth two bad ones at 28s. Mr. Bardill is a firm believer in piecework. England had got the skill and the machinery, and it remained for the business houses to show greater intelligence to march with the times. To study the requirements of foreign markets, foremen and managers held weekly conferences, at which ideas were suggested, to the general good.

In a very favourable report upon the progress of the Birmingham Tame and Rea Drainage works, for which Mr. Watson is the engineer, Dr. A. Bostock Hill, medical officer of health for the county of Warwick, remarks:—"It is no exaggeration to say that these works, as well as being the largest, are, in many respects, the most interesting in England at the present time. In going over them, extending as they do for six miles down the river, one cannot help but being impressed by the enormous magnitude of the task of the treatment of the sewage of upwards of three quarters of a million of people, and although years ago I inveighed against the terrible pollution caused in the river Tame, I am now pleased to be able to hear testimony to the improvements manifested, and to the high quality of the work which is being carried on"

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—The attendance on 'Change, both on Friday and Tuesday last, showed an improvement. There was a more hopeful feeling all round in the engineering department, whilst there was not much change to report, more orders were being received for textile machinery, which had been very slow for some time past. Tool makers are somewhat quiet. The electrical engineering trade continues fairly steady. The strong feature of the past week has been the advance in pig iron, which, so far as Middlesbrough is concerned, seems to continue. It is stated that much of this is due to speculation, in which American interest seems to run rather strongly. It is, however, pretty certain that stocks in consumers' hands are at a low ebb, and they have been compelled to cover current, and to some extent future, requirements. Merchants have, therefore, been acting more freely, and quotations were withdrawn for most makes early on in the week, and it cannot be said, with the exception, perhaps, of Middlesbrough and West Coast hematite, that prices have had any substantial advance. Derbyshire makers were willing to sell at about late rates, but holders of Lincolnshire, Staffordshire, and Lancashire asked fully 6d. to 1s. per ton advance on Tuesday, though it was very questionable whether the advance was obtained.

Direct imports of pig iron to Manchester for October were 5614 tons as against 4976 tons for the corresponding period of last year, but there is a general decrease as compared with September. Quotations, delivered Manchester, are as follows:—Lancashire foundry No. 3, 51s. to 51s. 6d.; Lincolnshire, 47s. to 47s. 6d.; Staffordshire, 49s.; Derbyshire, 50s. to 51s.; Middlesbrough, open brands, 52s. to 52s. 6d. Scotch: Gartsherrie, 55s. 3d. to 55s. 9d; Glengarnock, 53s. 9d. to 54s.; Eglinton, 52s. 6d. to 53s. Scotch delivered Heysham: Gartsherrie, 53s. 3d. to 53s. 9d.; Glengarnock, 51s. 9d. to 52s.; Eglinton, 50s. 6d. to 51s. Pig iron, f.o.t. Middlesbrough, 45s. 3d. West Coast hematite, f.o.t. Barrow, 54s. to 54s. 6d. Forge iron was in rather better request at about late rates. Lancashire forge is about 48s. 9d.; Lincolnshire, 45s. 8d.; Derbyshire, 44s. 6d. to 45s. Finished iron has been in much better request. During the past week or ten days inquiries, especially for bars, have been more numerous, and certainly holders are exceedingly firm. Lancashire and Yorkshire bars, £6 to £6 5s; Staffordshire, £6 7s. 6d; hoops, random, £6 17s. 6d. to £7 2s. 6d., with specially cut lengths 5s. extra; sheets, £7 5s. to £7 10s., delivered Manchester; corrugated sheets, £10 5s. to £10 10s., delivered Liverpool; steel bars, £6 to £6 2s. 6d.; English billets, £4 7s. 6d. to £4 10s.; hoops, £7 5s.; sheets, £7 5s. to £8 7s. 6d. It is satisfactory to note there has been a better demand for boiler plates on the Association basis of £6 17s. 6d., Manchester. The demand for manufactured copper has ruled rather quiet. Sheets quiet, at the advance noted last week. Copper sheets, £7 5s. to £7 7s.; seamless copper tubes, 9½d.; ditto brass, 7½d.; rolled brass, 6¾d.; and rolled wire, 6¾d.

The position in the coal trade does not show much change. The demand for domestic coal remains decidedly dull. There is a slightly better demand for forge and manufacturing coal, notwithstanding that forges are not yet fully employed; but, owing to the increasing work in the cotton trade and other textile industries, prices are very firm in that particular department. Quotations were:—Best coal for domestic purposes, 13s. to 14s.; medium, 12s. to 13s.; common, 9s. to 10s.; best steam and forge coal, 8s. 3d. to 8s. 9d.; engine slack, best, 7s. 6d. to 8s.; seconds, 6s. to 6s. 9d.; common, 4s. to 4s. 3d., at the pit. Unscreened, delivered Manchester Ship Canal, 8s. 9d. to 9s. 2d; screened ditto, 9s. 3d. to 9s. 9d.

Barrow.—The improvement reported in the hematite pig iron trade last week is fully maintained, but while there is a much more settled feeling in the market, there is not a large volume of business being done. Indeed, if it were not for the demand for Bessemer qualities on account of local steel makers, the business doing would be very small indeed, as there is a very poor demand in the open market, and those makers who depend on this source of demand for their trade are in a much worse position than those who have steel works of their own and are able to use, at any rate, a large proportion of their production in the manufacture of the superior metal. There has been no necessity yet to increase the make of the district; 23 furnaces are still in blast, but it is not probable this number will be reduced. Makers continue to quote 53s. 6d. net f.o.b. for mixed Bessemer numbers, but warrant iron has advanced 1s., and is now quoted at 53s. 6d. net cash sellers, seven days, buyers 6d. less. Yet, although warrant prices have advanced, there has been no operations in stocks, which remain steady at 12,392 tons.

The trade in hematite iron ore is confined within narrow compass. Sales of native ores are quiet, and prices remain low at 8s. 6d. per ton, a price that does not get much profit to the raiser after he has paid the miner and the royalty owner.

The steel trade is very quiet. There is no improvement in the steel rail trade, and orders are only few from all sources, while continental makers are keenly competing for all orders in the British market, and American makers are also showing some aggression. A better prospect is afforded in the plate trade. Orders for some time past have been very few, and the mills have not even been half employed. Prices are steady at £5 12s. 6d. net, f.o.b., for ship plates. Other classes of steel are in quiet demand, and orders are indifferently held.

Shipbuilders are quiet, and orders for commercial tonnage are few. There are, however, prospects of some important orders from foreign countries for warships, and it is thought probable some of these will come to Barrow.

Engineers are quiet in the marine department, but fairly busy otherwise. Boilermakers and ironfounders are well off for orders.

Shipping is very quiet, and exports from West Coast ports represent a small aggregate tonnage. Last week 3627 tons of pig iron and 5582 tons of steel were exported—total, 9209 tons; corresponding week last year, 14,044 tons; decrease, 4835 tons; total for the year, 625,639 tons; corresponding period of last year, 766,348 tons; decrease, 139,709 tons.

Coal and coke are in limited demand, at very low prices.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

WITH the advent of thorough November weather, though rather milder than usual, household fuel gets brisker. The demand, however, is not quite equal to what it was at the corresponding period of last year, when the climatic conditions were much more severe. The pits are working well, although there are some disputes in various parts, owing, in a considerable measure, to the complaint that the workings are too crowded, and that individual earnings are therefore low. Although a free market is being found for the coal brought to bank, the advance which was decided upon some time ago in several quarters has by no means been generally maintained. From 3d. to 6d. per ton above September quotations is as much as prevails in most directions, prices being thus from 9s. 9d. to 10s. 6d. per ton for the qualities of coal most in demand. In Silkstones, which are scarce, 12s. per ton is asked, with secondary sorts about 1s. per ton less.

The demand for steam coal is not so animated as it was. A fair tonnage is still being sent to Hull for the export trade, and the business done with Grimsby is large, owing to the heavy tonnage required by steam fishing trawlers. Goole gets most of its supplies from West Yorkshire, and is reported to be taking freely. Steam coal for railway companies is being heavily delivered under contracts for locomotive purposes at 8s. to 8s. 3d. per ton in owners' wagons. There is less doing in the open markets for coal of this description. For gas coal, on the other hand, the demand gets keener as the season advances. Very little of the coal now being supplied is for open sale, nearly the whole of it being sent under contract. Those who require supplies in the open market have to pay a little more than the contract price. For good slack and smudge the Lancashire demand is still maintained, but for inferior sorts there is very little trade, colliery slack and smudge being especially quiet. The demand for coke is very feeble, the diminished output being more than sufficient to meet all market requirements.

The Yorkshire coal trade with Hull again shows a slight increase during October. During the month there were received at the port from ninety-four collieries 355,240 tons of coal, as compared with 338,640 tons for the corresponding month of last year. For the completed ten months of the year the weight is 2,966,264 tons, and for the corresponding period of last year 2,893,712 tons. The tonnage sent to Hull last year, with a single exception—that of October, 1900—is the largest on record. Values for the present year do not compare favourably with other years, but the weight, it will be seen, continues to get greater. The exports last month from Hull were 169,244 tons, which is an improvement of 11,868 tons as compared with October of last year. The exports for the ten completed months show a weight of 1,326,236 tons, as compared with 1,350,809 tons for the ten months of 1903. Sweden, with 45,558 tons, and North Russia, with 36,074 tons, are the largest customers, the corresponding weights for October of last year being in the case of Sweden 43,466 tons and for Russia 38,829 tons for the month. Germany took 27,728 tons, against 23,194 tons; Holland, 15,828 tons, against 7093 tons. Increases were also shown by Belgium, East Indies, Egypt, France, and Norway. On the other hand, the decreasing markets are South America, which fell from 14,866 tons to 6632 tons, Australia, Denmark, Italy, South Russia, and Turkey.

More confidence is expressed in the iron and steel trades, but as yet no appreciable increase of business has resulted. The belief is general, however, that the bottom has now been reached, and any change must be in an upward direction; but whether there will be a permanent improvement before the beginning of next year is very doubtful. Iron prices are quoted as follows:—West Coast hematites, 62s. 6d. to 65s. per ton; East Coast ditto, 58s. 6d. to 59s.; Lincolnshire No. 3 foundry, 45s. 6d.; Lincolnshire forge, 44s. 6d.; Derbyshire No. 3 foundry, 47s. to 48s.; Derbyshire forge, 44s. to 45s.; bars, £6 10s.; sheets, £8 10s. to £8 15s.

In steel the condition of trade remains very much as last reported. Several houses, largely engaged in the crucible steel trade, have reduced the number of their workers during the last few weeks; but others again have been able to do more, and thus, through the uneven way in which work is coming in, the average is about maintained. Very little work indeed is coming from the shipbuilding yards and engineering establishments in South or North, and the outlook is by no means promising. In Bessemer and Siemens steel the output is but moderate, and altogether insufficient to keep the plant fully employed. The demand for fast-cutting special tool steel, to which we have repeatedly referred of late, is well maintained by several local firms. Another gratifying feature is that the English machine-tool makers are coming to the front, and find a readiness among manufacturers to prefer the British-made to the American-made tool.

In several of the large establishments in the East End fresh orders have recently been obtained, chiefly on home account, the latter market showing symptoms of waking up a little. The chief disappointment is in marine and railway material, which, it was hoped, would by this time have been in fairly brisk request. This hope, however, has not been realised, home companies continuing to order from hand to mouth, and little is coming forward from the colonial markets. Complaint is made that the Indian Government are placing orders for material required by the State railways with German manufacturers, who quote easier prices with the express purpose of underselling British work in British home and colonial markets.

The foreign trade in cutlery for October amounted to £61,431, as compared with £65,882 for the corresponding month of 1903; for the ten completed months of the year, £573,641, compared with £569,638 for the ten months of 1903.

For the Australian, New Zealand, and South American markets there is now expectation of improved business. The welcome rains that have fallen in Australia have generally brightened prospects for better business in cutlery, edge tools, as well as in hardwares and similar goods. The orders recently to hand are larger and more numerous, while the reports from the various agents are encouraging. On the other hand, business has been greatly interfered with in the Eastern markets, owing to the continuance of the war.

NORTH OF ENGLAND.

(From our own Correspondent.)

SINCE my last report ordinary business in iron and steel has been considerably interfered with by the sharp burst of speculation that has shown itself in Cleveland warrants, and practically consumers have stood aside, waiting the outcome of the gamble, which certainly is keener than has been known for several years. It cannot be denied that there is some slight improvement in the iron and allied industries, but it must be confessed that there is nothing in this which would afford any justification for the rise in warrant prices which has taken place, especially within the last week; in fact, if statistics are looked at, they rather favour a move downward instead of upward. It is generally acknowledged that what has been going on in the warrant market during the last few days has been a gamble pure and simple, and regular buyers of iron see no reason to think that prices will be upheld after it is over. The time of the year and the condition of trade are against a genuine advance in pig iron prices, but these circumstances are ignored by those "engineering" the gamble.

It would appear that the speculative operations are mainly carried on by London houses, who previously had been operating extensively, and it is said profitably, in copper, tin, &c., and who believed that there was something to be gained out of transactions in pig iron, for it might be expected that the rise would extend to that, especially when other metals were holding up in value. They looked upon Cleveland warrants at 43s. per ton as cheap, and regarded the task of pushing the price up as not a very difficult one. Therefore they began to buy Cleveland warrants rather freely, and prices rose in consequence, with the result that other speculators who were largely oversold made haste to cover this, also helping up the price.

Of course there was no speculation in Scotch or hematite warrants, as the stock of them is too small, and operations thus had in this gamble to be confined to Cleveland warrants. It is several years since there was such a rapid advance in prices of warrant iron. For nearly three months after the end of July the fluctuations never went below 43s. nor above 43s. 6d., then about the middle of October they commenced to move faster, and by the 25th 44s. had been reached, with 45s. in little more than a week, and on 4th inst. 46s. cash was reported. On Monday this week sellers asked 46s. 1d. and buyers offered 46s. 0½d., and these so far have been the highest rates, for some of the speculators then commenced to sell out and realise the substantial profit that was to be obtained by those who had bought prior to last week. That led to prices dropping 6½d. per ton, but the upward movement was resumed on Wednesday, 4½d. of the loss being regained. Monday's price—46s. 0½d. cash buyers—was 10d. per ton above the maximum of the spring rise, which until now has been the best of the year, and it was 4s. 4½d. per ton above the minimum figure of the year, that being reported on January 21st.

One of the results of these speculative operations in warrants has been a most rapid increase in the stock of Cleveland iron in Connal's public warrant stores. Every day this month, with one exception, the increase has been over 1000 tons a day, and on Monday it was upwards of 2000 tons. Thus on 8th, 123,984 tons of Cleveland iron were held by Messrs. Connal and Co., an increase for the month of no less than 8956 tons. Last month the increase was 20,139 tons, and in the last three months about 38,000 tons have been added. It was early in July when stocks began to increase, and since then 45,971 tons have been added to the store. The almost unprecedented rapid advance of the current month is due to the speculation in warrants. People are rushing iron into store as fast as they can, and makers themselves are said to be among them. When they could get 1s., and even 1s. 6d. per ton more for warrants than would be given for No. 3 makers' iron producers were tempted to sell warrants, and they have to send iron into the stores to enable them to fulfil their obligations to deliver warrants. This it is probable they will have to continue to do, and it is likely that Connal's stock will increase for some time to come. That will not tend to keep the value of iron up after the gamble is over. All the iron that can be sent into store now is being rushed in. At present this feature of the market is ignored, being overshadowed by the operations of the speculators. The same may be said of poor shipments. From Cleveland this month only 22,881 tons of pig iron have been sent, against 23,413 tons last month, and 36,869 tons in November, 1903, all to 9th.

Prices of Cleveland foundry pig iron have risen this week, but not to the same extent as warrants. One firm appears to have sold No. 3 at 46s. per ton, but the most that other firms have realised was 45s. 3d., and 45s. was the general price of makers who, a fortnight ago, would not have refused 43s. 6d. No. 1 has been advanced to 47s., and No. 4 foundry to 44s. The lower qualities have been hardly affected by the upward movement in warrants—they have risen no more than 6d. above the lowest—whereas No. 3 has gone up 2s. 3d., and Cleveland warrants 2s. 9d. from the recent minimum. Thus, No. 4 forge is 3s. 3d. per ton cheaper than No. 3, whereas it should be only 1s. less, and in the summer was no more than 6d. less. To-day, No. 4 forge is at 42s.; mottled at 41s.; and white at 40s. 6d. per ton. This week inquiries have been received in this district from the United States for considerable quantities of No. 1 Cleveland pig iron, and for hematite iron for delivery in the early part of 1905.

For East Coast hematite pig iron the demand has improved, and producers have been able to advance prices. The business has been altogether unaffected by the speculative operations in Cleveland warrants. Producers now look upon the prospects as encouraging, as the steel plate trade is more favourable. The price of mixed numbers, which was 50s. 6d. last week, rose to 51s. early this week, and now 51s. 6d. is the general quotation, a total rise recently of 2s. per ton. But hematite is still cheap, for whereas it should be 10s. per ton above No. 3 Cleveland iron, it is

to-day no more than 6s. 3d. above. Rubio ore is firm at 14s. 7½d. per ton c.i.f. Tees, but now that the Baltic season may be considered over reductions in freight may be looked for, and that that will cheapen the delivered price of the ore. That will be a set-off against the stiffer prices of furnace coke, medium qualities of which, delivered at the Middlesbrough furnaces, are realising 14s. per ton.

The manufactured iron and steel industries, on the whole, are somewhat less affected by depression than they have been, but the improvement in no branch is yet very pronounced. Still, producers take a more hopeful view, and some have as many orders on their books as they care to take at the present prices. Their salesmen report that throughout the country customers are more disposed to do business than they have been for the last two years. The price of steel ship angles, which was lately reduced to £4 17s. 6d., less 2½ per cent., has been put up again to £5, less 2½ per cent., partly because of better demand and partly because of the higher cost of hematite pig iron. For steel ship plates nothing less will be accepted for home orders than £5 12s. 6d., less 2½ per cent.; but iron ship plates, which have been standing at £6 7s. 6d., less 2½ per cent., for a considerable time, are now obtainable at £6, less 2½ per cent., the producers having found it necessary to lower the price, as consumers were using steel plates in preference; they did not see their way to give 15s. per ton more for the iron plate, even for special purposes. Thus the orders for the latter were getting to be very few indeed. Steel boiler plates are quoted at £7, less 2½ per cent. Steel bars are at £6, and iron bars at £6 2s. 6d., both less 2½ per cent. The rail trade is a little more active, as well on home as on export account, and heavy steel rails are quoted at £4 10s. net, f.o.b., that being the figure fixed by the International Syndicate.

Some of the founders report a rather better demand, but no higher prices can be realised. The Whessoe Foundry Company have obtained from the Admiralty an order for two steel tanks, each 90ft. diameter by 36½ft. high, for storing oil at the Naval Works at Portland.

A very fair business is being done in gas, coking, and bunker coals, but it is falling off rapidly in steam coal, but that is only what might be looked for at this season of the year. Best gas coal is at 8s. 1½d. per ton, and seconds at 7s. 9d. per ton, f.o.b. Best steam coals are at 9s, with seconds at 8s. 3d, and ordinary smalls at 3s. 9d. to 4s. There is somewhat more doing in coke, and the price is also influenced upward by the rise in pig iron; thus, 14s. per ton, delivered at the Teesside furnaces, is readily obtained for medium qualities. Foundry coke is at 15s. 3d. per ton, f.o.b.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE pig iron market has again been very strong, and a large business has been done in Cleveland warrants at high prices. An impression is very general on 'Change that the upward movement in warrants is of a speculative nature. The buying is alleged to come largely from London. It is asserted that the indifferent condition of trade does not justify the very decided rise in prices. This may be so, but it may be pointed out that purchases are frequently made a considerable time ahead, even before the public has any knowledge of contracts that are under arrangement. At the present time, also, the stocks of iron, both at Middlesbrough and at Glasgow, are much smaller than they have been for many years; and for this reason the market is more likely to respond quickly to any improvement in the demand.

Business has been done in Cleveland warrants at 45s. 6½d. to 45s. 10½d. cash, 45s. 6d. seven to fourteen days, 45s. 11d. six days, and 45s. 8½d. to 46s. 3d. one month. Scotch warrants are quoted 51s. 6d., and Cumberland hematite 53s. 4½d. There has been some inquiry for the latter, but little or nothing doing in the former.

Prices of Scotch makers' iron have been improving in sympathy with the warrant market. G.M.B., No. 1, is quoted at Glasgow 53s.; No. 3, 49s.; Carnbroe, No. 1, 53s. 6d.; No. 3, 49s. 6d.; Clyde, No. 1, 56s. 6d.; No. 3, 50s. 6d.; Langloan, No. 1, 63s.; No. 3, 53s. 6d.; Gartsherrie, No. 1, 57s.; No. 3, 51s.; Summerlee, No. 1, 57s.; No. 3, 51s.; Coltness, No. 1, 63s. 6d.; No. 3, 53s. 6d.; Glengarnock, at Ardrossan, No. 1, 58s.; No. 3, 51s.; Eglinton, at Ardrossan or Troon, No. 1, 52s.; No. 3, 49s. 6d.; Dalmellington, at Ayr, No. 1, 52s. 6d.; No. 3, 49s.; Shotts, at Leith, No. 1, 58s.; No. 3, 51s. 6d.; Carron, at Grangemouth, No. 1, 58s.; No. 3, 52s. per ton.

Since last report two furnaces have been transferred from hematite to ordinary iron. There are now 41 furnaces making hematite, 37 ordinary, and six basic iron, the total of 84 thus blowing in Scotland comparing with 86 at this time last year.

There is a steady demand for Scotch hematite, which is rather firmer, merchants quoting 55s. 6d. for delivery at the West of Scotland steel works.

The shipments of pig iron from Scottish ports in the past week amounted to 5478 tons, compared with 4207 in the corresponding week of last year. There was despatched to the United States 25 tons, Canada 760, South America 100, India 225, Australia 275, Italy 450, Germany 170, Russia 30, Holland 86, Belgium 5, China and Japan 260, other countries 84; the coastwise shipments being 3008 tons, compared with 2772 tons in the corresponding week of last year.

The arrivals of Middlesbrough pigs at Grangemouth amounted to 12,073 tons, compared with 15,482 in the corresponding week, showing a decrease of 3409 tons.

Notwithstanding the upward movement in the warrant market, there is little or no change for the better in the finished iron and steel trades The makers of malleable iron find it difficult to keep their works going full time, and it is no easy matter to maintain prices, prevention of competition being out of the question.

A meeting of the Scotch steel makers was held in Glasgow on Tuesday, when it was decided to reduce the price of ship plates 2s. 6d. per ton. The price will now be £5 12s. 6d., less the usual 5 per cent. discount. No alteration was made in the prices of bars, angles, or boiler plates. The trade continues very dull. Shipbuilding orders have been scarce on the upper reaches of the Clyde, where the great bulk of the work is usually done.

It is reported that Messrs. Russell and Co, of Port Glasgow, have contracted to build two steamers of 6000 tons each, for owners at Trieste. One of the vessels is for cargo, and the other will be employed in the emigrant trade.

The coal trade has been rather less active in the shipping department, and the clearances at the Scottish ports are reduced. They amounted in the past week to 230,589 tons, compared with 259,279 in the preceding week, and 213,426 in the corresponding week of last year. Testimony has been borne by leading authorities to the effect that the coal tax is very seriously hampering the trade, especially on the East Coast. The tax of 1s. per ton represents about a sixth of the actual price obtainable, and it is said to be severely handicapping merchants in their competition with continental countries. The output of coal is heavy, and while merchants have so far been able to obtain fairly steady prices from the home consumers, competition is on the increase, and business getting more difficult. Prices of all sorts of coal are this week nominally unaltered, although in reality the tendency appears to be easier.

It is very gratifying to note that the repeated conferences between representatives of the Scottish coalmasters and miners have at length resulted in an agreement, which will, no doubt, be confirmed by their constituents, on the wages question. A good deal of anxiety has recently been felt on this matter, and it was feared that a rupture might take place, ending in a general strike. Under the agreement now concluded it is hoped that employers and workmen will be able to work amicably for a long time to come.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

ONE of the most important questions now before the Welsh coal trade is the appeal of coalowners to the men to concede a reduction of 5 per cent. in wages. Considering that the relief of about 6d. per ton would be of service to the majority of collieries, which do not, as a rule, share in the large contracts, the men are all advised to oppose it; but judging from a colliers' meeting held this week, where the idea was opposed, it will not be conceded unless the leaders of the men support it. The equitable ruling of the sliding scale is recalled in all these crucial times by old authorities, and the regret is often expressed that the old method, like the old rulers, is gone. At present colliers are more interested in labour candidates and parliamentary movements. Mr. Richards' success in West Monmouthshire, in gaining the seat vacant by the death of Sir Vernon Harcourt, is certain to prompt others.

Substantial coal contracts are receiving attention, particularly in the Cardiff district. I note a few of the more prominent:—The Italian Government for 23,000 tons steam; the Orient Pacific line, 60,000 to 80,000 tons, secured by Lewis, Merthyr, to be delivered during 1905; the Cunard line large orders not placed; White Star line also in the market; and Admiralty supplemental orders are expected to total to a large amount. Mid-week it was stated on 'Change, Cardiff, that the Royal Mail Steam Packet Company had placed orders with local firms for 150,000 to 200,000 tons. The firms stated to have secured orders are:—Albion; Lewis, Merthyr; and Powell, Duffryn. Prices believed to range between 12s. 6d. and 13s.—coal: best steam. Should these figures prove to be correct, they will still further confirm the opinion of authorities quoted last week, that the tendency of prices is downwards. The P. and O. is in the market for 20,000 to 30,000 tons.

The character of the Welsh coal trade may be briefly summed up: a good deal of congestion, due in a measure to storms delaying tonnage; lack of prompt business; spurt in Monmouthshire coals; slackness in house coals; which appear to be in the old groove often noticed at the time of the year before a start is made on the upward grade.

Mid-week prices at Cardiff were as follows:—Best steam, 13s. 3d. to 13s. 9d.; best seconds, 12s. 6d. to 13s.; ordinary seconds, 11s. 6d. to 12s.; drys, 11s. 9d. to 12s. 6d.; best smalls, 7s. 3d. to 7s. 6d.; best ordinaries, 6s. 3d. to 6s. 6d.; seconds, 5s. 9d. to 6s.; some cheaper kinds at 5s. 6d.

Monmouthshire semi-bituminous: Best, 11s. 9d; best ordinaries, 11s. 3d. to 11s. 6d.; seconds, 10s. 6d. to 10s. 9d. House coal: best, 16s. 9d. to 17s.; best ordinaries, 13s. 6d. to 14s. 6d.; seconds and other kinds, 10s. 6d. to 13s.; No. 3 Rhondda, 13s. to 13s. 6d.; brush, 12s. to 12s. 3d.; small, 9s. 6d. to 10s.; No 2 Rhondda, 9s. 9d. to 10s.; through, 8s. 3d. to 8s. 6d.; small, 6s. 6d. to 6s. 9d. Patent fuel, 12s. 6d. to 13s. Pitwood strong, 18s. 3d. to 18s. 9d., advancing. Anthracite prices remain, but demand is improving; malting selling at 20s. to 21s; large, 10s. to 12s. 6d.; cobbles, 17s 6d. to 18s; nuts, 18s. 6d. to 19s.; peas, 11s. to 12s.; culm, 5s. 3d to 5s. 6d.; duff, 4s.

Swansea prices for steam are 12s. 6d. to 13s., and for house coal, Rhondda, from 13s. 3d.

The compilers of statistical returns are now preparing for the usual task of scheduling the business of the year in connection with our leading industries. Coal may be expected to figure well; probably a record will be shown, as the war scare not only affected our Admiralty purchases, but led to large shipments on Japanese and Russian account. A first total from trustworthy sources already figures out the war shipments at 2½ million tons.

The coal hauliers are again becoming aggressive, and, at a large meeting in the Aberdare Valley this week, it was suggested by some of the more violent leaders to give notice on the 1st of January. This, fortunately for the peace of the district, was outvoted, and the more reasonable course was adopted of adjourning and bringing the question in dispute before the Central Executive, to whom delegates had been sent.

The Cawdor strike is ended after lasting eight weeks.

At the Cwmbran foundry of Guest, Keen and Co., where a large number of men are employed chiefly on iron chairs for the Indian railways, there was an escape of gas from beneath the slag a few days ago, and only prompt action saved the men affected. In a boiler case at Blaenavon two men were overpowered by the gas and succumbed.

Steel cargoes from the States appear to have stopped, temporarily it is thought; but several cargoes of steel sheet bars from Antwerp and Rotterdam have come into Newport. Amongst the imports this week have been pig iron from Mostyn, North Wales, from Spain, Millom, Middlesbrough, and Whitehaven, and large quantities of scrap iron and scrap steel from London.

Iron ore from Passages and Bilbao for Ebbw Vale, and from Bilbao and Santander for Guest, Keen and Co., have been in evidence.

Guest, Keen and Co. continue their large make of steel rails. An important order, I hear, is in hand for Buenos Ayres. This is one of the heaviest sections—100 lb. to the yard. Fish-plates and billets were also worked off last week. In tin bar there is still scope for great improvement. Some of the tin-plate mills in the Swansea district are now using exclusively German steel. The steel works generally in the valley are only moderately employed, affording marked contrast to the tin-plate works, where the fullest activity has been shown. Last week over 70,000 boxes were brought from works. Shipments exceeded 66,000 boxes, leaving stocks at about 159,000 boxes.

I note amongst the customers for tin-plate, and general:—Far Eastern ports, 1500 tons; River Plate, 1200 tons; New York, 800 tons; Danubian ports, 800 tons. France, Germany, Italy, and Holland also figured for big totals.

On 'Change, Swansea, mid-week, it was reported that pig iron was showing an upward tendency, and an advance in warrants taking place all round:—Scotch, 3d. per ton; Middlesbrough, 1s.; and hematite, 6d. Steel—wrought, cast, and scrap—commands higher values.

In finished iron and steel a better tone prevails in tin bars, and makers are quoting higher, but buyers object. Tin-plate trade is well placed, and forward bookings of importance are under consideration and discussion. All works busy. Latest prices:—Pig iron: Glasgow warrants, 51s.; Middlesbrough No. 3, 45s. 6½d.; hematite, 53s. 3d., mixed numbers, Cumberland. Sheet iron, £7 17s. 6d. to £8; steel sheets, £7 15s. to £7 17s. 6d.; steel rails, heavy, £4 5s. to £4 10s.; light, £5 5s. to £5 10s. Bessemer bars, £4 2s. 6d.; Siemens, £4 5s.

Tin-plates: Bessemer steel coke, 12s. 1½d.; Siemens coke finish, 12s. 3d. to 12s. 6d.; ternes, per double box, 28 × 20 c., 21s. 6d., 22s. 6d. to 25s. Big sheets for galvanising, 6ft. × 3ft. × 30 g. per ton f.o.t., £8 12s. 6d. to £8 15s, finished black plate, £8 12s. 6d. to £8 17s. 6d.; block tin, £131 7s. 6d.; lead, £13 2s. 6d.; spelter, £23 17s. 6d.; copper, £63 2s. 6d. Iron ore: Rubio, 13s. 6d.; coke, 19s. to 21s. Patent fuel, 11s. 9d. to 13s.; orders fair, tonnage scarce. Pitwood, 19s.

Steel millmen and sheet millmen have withdrawn from Wages Dispute Board tin-plate trade.

Amongst probable movements of note is the entry of the Barry Railway into the Sirhowy Valley. The presence of some of the directors there this week has given support to the probability, which would necessitate parliamentary sanction.

Aberdare is the latest town to adopt the electric tramway movement. This and other local efforts will see a practical start next session.

Amongst the steamers despatched with coal on Saturday from Cardiff was the Clarissa Radcliff, one of the large fleet of Evan Thomas Radcliff and Co. She carries 7500 tons, on a shallow draught of 24ft.; built at Stockton by Sir N Ropner and Co., and engined by Messrs. Blair.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market, owing to rough weather, is rather quiet; prices unchanged. House coal is in fair request. The quantity of coal shipped for the week ending November 5th was 71,815 tons—foreign, 61,428 tons; coastwise, 17,387 tons. Imports for the week ending November 8th:—Iron ore, 7350 tons; bars, &c., 2366 tons; pig iron, 950 tons; scrap, 295 tons; cement, 135 tons; deals, &c., 1283 loads; pitwood, 2548 loads.

Coal—Best steam, 11s. 6d. to 11s. 9d.; seconds, 10s. 6d. to 10s. 9d.; house coal, best, 15s.; dock screenings, 6s.; colliery small, 5s. 3d. to 5s. 6d.; smiths' coal, 9s. Pig iron—Scotch warrants, 50s. 9d.; Middlesbrough, No. 3, 45s. 10d.; Middlesbrough hematite, 54s. f.o.b. Cumberland prompt. Iron ore—Rubio, 13s. 6d.; Tafna, 14s. 6d. Steel—Rails, heavy sections, £4 5s. to £4 10s.; light ditto, £5 5s. to £5 10s. f.o.b.; Bessemer steel tin-plate bars, £4 2s. 6d.; Siemens steel tin-plate bars, £4 5s., all delivered in the district, cash. Tin-plates—Bessemer steel, coke, 12s. 1½d. to 12s. 3d.; Siemens, coke finish, 12s. 3d. to 12s. 6d. Pitwood—18s. to 18s. 3d., ex ship. London Exchange telegrams—Copper, £63 2s. 6d. to £63 5s.; Straits tin, £131 10s. to £131 12s. 6d. Freights—Active, and slightly firmer.

TRADE AND BUSINESS ANNOUNCEMENTS.

MESSRS. BARRY, HEAD AND CO., of 26, Lombard-street, E.C., inform us that they have been appointed sole London agents to the Denby Iron and Coal Company, Limited.

THE North British Station Hotel, Glasgow, is to be ventilated with electric fans, which are being supplied by Messrs. Matthews and Yates, of Cyclone Works, Swinton, Manchester, who have also supplied the fans for the company's hotel at Edinburgh.

CONTRACTS.—Alley and McLellan, Limited, have received an order to supply two of their "Sentinel" patent compound water cooling air compressors for Wm. Beardmore and Co.'s, Limited, new shipyard at Dalmuir. These machines will have a total capacity of 5500 cubic feet per minute at standard speed. They will be coupled direct each to a 400 brake horse-power Ochelhauser gas engine, supplied by D. Stewart and Co. (1902), Limited, who hold the whole contract for these plants.—Messrs. C. A. Musker, Limited, of Liverpool, have received an order from the London County Council for three electric car traversers for the tramway generating station at Greenwich.—We are informed that Raworth Traction Patents have received instructions to equip forty new cars for the Birmingham and Midland tramways, with regenerative control.—Messrs. Bruce Peebles and Co., Limited, have secured the contract for 8¾ miles of permanent way, complete electrical equipment on the overhead system, rolling stock car shed, &c., for the Falkirk and District Tramways Company.—The Holwell Iron Company, Limited, Asfordby, Melton Mowbray, has received the order for the cast iron pipes required for the Sutton District Water Company, Surrey.—The Hart Accumulator Company informs us that it has secured the contract for the supply of a storage battery, consisting of 278 of its standard central station type cells, required for the electric lighting of Northwood, Uxbridge.

TIMBER SLEEPER PRESERVING IN AMERICA.—The rapid destruction of the great forests of the United States of America has forced upon the railroads a very serious problem in connection with the supply and preservation of timber and outdoor construction work, especially of sleepers. Since the supply of timber for this purpose will probably decrease as time goes on, many efforts have been made in the direction of perfecting processes to preserve the sleepers from insects and decay. The Ayer and Lord Tie Company, Chicago, has erected a number of large plants for this purpose in different parts of the country. The timber to be treated is placed in air-tight cylinders, where it is first subjected to steam under pressure, to remove all air from the pores of the wood, after which the air and steam are exhausted. For producing a vacuum, a single-cylinder horizontal direct-acting wet vacuum pump is generally used, in which the piston-rod stuffing-box and the piston are submerged. After all vapour and gases are removed, creosote is pumped into the tank, and forced into the wood by pressure. The pressure pump is designed, as a rule, to work against 300 lb. pressure per square inch. A single-cylinder fly-wheel air compressor, having a 6in. steam cylinder, a 6in. air cylinder, and a 6in. stroke, is next used to force air into the tank, displacing the creosote and returning it to an elevated storage reservoir.

GLASGOW UNIVERSITY ENGINEERING SOCIETY.—The first meeting of the fourteenth session of the Glasgow University Engineering Society was held on the evening of Thursday, the 3rd November, in the lecture-room of the engineering department. Professor Barr, who presided, introduced the honorary president, Mr. W. A. Chamen, M.I.E.E., chief engineer of the Glasgow Corporation. After thanking the Society for having done him the honour to elect him honorary president, Mr. Chamen went on to deliver an address, in which he referred to the possible and probable developments of electricity supply by its becoming the very foundation of many industries in a way not at present realised. The electric power supply companies, of which several have now been formed in various parts of the country, though not many have as yet commenced to supply, had before them the prospect of being able to provide power to existing factories dotted about the country, and even to coal pits for driving the winding machinery which brings the coal to the surface, and the other machinery both above and below ground, at a cost below that at which the various separate industries can generate it themselves. The South Wales Electric Power Company was already making satisfactory progress in this way, and there was no reason why the others, such as the Clyde Valley Company, may not in time be equally successful. These companies also rendered the running of tramways and light railways in country districts an easier and more economical matter, while it would also become practicable to run electric accumulator motor cars in which the accumulators could be made comparatively small and easily removable for charging after quite short runs and be replaced by other sets ready charged. The possibility of applying electricity to agricultural purposes was also, he said, worthy of consideration. The reduction of the smoke nuisance in cities was, moreover, to be looked for by the abolition of the ordinary domestic coal-burning grate. Electricity and gas between them could bring about the abolition of domestic smoke. At the close of the lecture Mr. J. G. Johnstone, the president, proposed that the name of Geheimrat Karl Busley, of Berlin, be added to the list of honorary members of the Society. Geheimrat Busley, he said, had many claims to this honour. He was president of the Schiffbau Technische Gesellschaft, an author of distinction, and an eminent authority on marine engineering. The Society were especially indebted to him for the valuable assistance he had given in arranging and carrying through the programme of the joint tour which the Glasgow Society, with the members of the University College London Engineering Society, made in Germany in July. The election was unanimously agreed to. A vote of thanks was thereafter proposed, and heartily accorded to Mr. Chamen for his interesting and suggestive address, and the proceedings terminated.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE accounts received of the business in iron and steel over there are still disappointing. Now and then the report of a slight improvement is given, which might lead one to expect that the worst had been experienced; but then, again, very depressing accounts come in of the want of confidence, and an unwillingness of consumers to place any but the most urgent contracts. In short, the position all round must be considered unsatisfactory, and prospects continue clouded.

The iron market in Silesia remains in a languid state generally, although some branches appear in better occupation than last month. Buyers still hold off, and the orders placed upon the week have all been small, and employment, therefore, shows an abatement in a number of instances. Export in malleable iron has slightly increased, also at the tube mills a lively activity can be noticed; but the plate and sheet trade is without animation. A further downward movement can also be stated in the scrap iron business.

Ironmasters in Rheinland-Westphalia are doing less now than at this time last year. In pig iron demand and sale continue weak and irregular, as before, and a lifeless condition prevails in the semi-finished steel department. Scrap iron is very dull. In finished iron and steel buyers show an unusual amount of reserve now, and the business done upon the week was, therefore, of the most limited description. The plate trade shows very little life, and in wire only a moderate business is done.

Quietness prevails on the Silesian coal market. Total deliveries in coal in Silesia during the first two weeks in October were on an average 5780 wagons per day, which is 400 wagons less than in the same period last year, and 200 wagons less than in the last two weeks in September. The consumption in engine coal will probably rise in the present month, owing to an increasing demand from the sugar mills. A fair trade is done in coke.

Business transactions on the Rhenish-Westphalian coal market show an improvement this week against last, export being stronger than formerly. On local account a moderate demand only comes in. From January to September of present year, output in pit coal was 88,910,291 t. in Germany, against 86,062,746 t. in the same period the year before: production in brown coal was 34,938,033 t., against 32,776,523 t.; in coke, 9,095,480 t. were produced, against 8,483,601 t.; and in briquettes, 8,311,871 t., against 7,570,127 t. Import in coal during the period from January to September was, in pit coal, 5,128,395 t., against 4,972,095 t.; in brown coal, 5,518,189 t., against 5,901,798 t.; in coke, 381,919 t.; against 321,350 t.; in artificial coal, 88,100 t., against 62,130 t.; and in peat, 7111 t., against 10,909 t. Export in pit coal was 13,028,463 t., against 12,757,841 t.; brown coal, 16,987 t., against 17,712 t.; coke, 2,021,000 t., against 1,880,351 t.; artificial coal, 650,607 t., against 630,930 t.; and peat, 9595 t., against 12,819 t.

The tendency last week was firmer than previously on the Austro-Hungarian pig iron market. In finished iron a moderate business is done, plates especially are very languid. The rail works are likely to be in better employment soon, for the mills engaged in the production of rails have been requested recently to submit offers for the supply of rails for the Austrian State Railways. The approximative demand of the State Railways would be for 1905 in rails, 43,400 t.; fish-plates, 2200 t.; plates, 4300 t. When the orders have been placed, the deliveries are to begin in December already. The average requirements of the local and small lines would be for 1905 10,000 t. rails, 500 t. fish-plates, and 587 t. plates.

Owing to fairly large orders given out by the sugar mills, the tone of the Austro-Hungarian coal market has been a trifle more lively upon the week. The coke trade, too, is developing satisfactorily.

Fair accounts are being received from the French iron industry. On the Paris market a brisk business is now being done, and this has been favourable to the tone of the market in general. Blast furnace No. 5 of the Longroy Ironworks, which was extinguished on the 5th of July of present year, has been continually in blow since January, 1884, producing 483,531 t. during its twenty years' existence.

A rise in demand, and a consequently improving tone, is reported from the French coal market.

The Belgian iron industry is likely to become a little more animated now after the forming of the International Rail Convention. Rails are in very good call at present; the same is reported of girders, which have been in unusually fair demand recently, and there will probably be a syndicate for this article soon. According to reports from Brussels the Belgian zinc industry is likewise contemplating the forming of a convention.

Since the reduced September prices have come into force firmness has been increasing on the Belgian coal market, and the present situation is rather a healthy one, although purchases in engine and house coal are still far from extensive.

ROYAL INSTITUTION.—A general monthly meeting of the members of the Royal Institution was held on the 7th instant, Sir James Crichton-Browne treasurer and vice-president, in the chair. H.H. the Raj Rana Bhawani Singh Bahadur of Jhalawar, Mr. J. Jennens, and Mr. E. J. Preston were elected members. It was announced that the Institution had received a bequest of £100 under the will of the late Miss Harriet Jane Moore. The special thanks of the members were returned to Dr. Ludwig Mond for his donation of £755 for the purpose of erecting a lift from the basement to the second floor of the Institution, and any surplus after the completion of the work to go to the Research Fund. During the recess the entrances and exits of the lecture-room of the Royal Institution have been materially improved by the erection of two covered-in iron staircases, and the widening of the doorways, and the ceiling has been considerably raised.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

28th October, 1904.

23,207. SHAVING APPARATUS, W. R. Allen, Kingston-on-Thames.
23,208. TOBACCO and MATCH-BOX, S. Kremer and M. R. Dawe, Grandiffaith, Monmouth.
23,209. BUTTON-HOLE SCISSORS, R. Samuelson, Rugby.
23,210. BUILDING CONSTRUCTION, J. W. Redfern, Kingston-on-Thames.
23,211. BRAKES for AUTOMOBILES, M. W. Dickins, W. A. Bowens, and W. H. Broadfoot, Birmingham.
23 212. APPARATUS for LIGHTING GAS BURNERS, D. Hall and J. H. Kay, Manchester.
23,213. LOOMS for WEAVING, P. Oakes, Burnley, Lancs.
23,214. BAND SAW SHARPENING MACHINES, C. Walsh, Preston.
23,215. MOVABLE LETTER SHOW CARD, G. Robinson, Ipswich.
23 216. PARALLEL BENCH VICE, S. R. Fish, Kettering, Northamptonshire.
23,217. IMPROVED ACETYLENE LAMP, S. White, Stockton-on-Tees.
23,218. ORNAMENTS for BEDSTEADS, C. E. Parr, Birmingham.
23,219. CAPS for ELECTRIC LAMPS, H. Ashton, Manchester.
23,220. SUPPORTS for LADIES' SKIRTS, N. D. Taylor, Nottingham.
23,221. THUMBOGRAPHS, J. G. White, Romford, Essex.
23,222. STOP MOTIONS for ROVING FRAMES, W Muir, G. W. Somerville, and Howard and Bullough, Limited, Accrington.
23,223. TREATING SKIMMINGS from TIN-PLATE MACHINES, S. Daw, Llanelly, Carmarthenshire.
23,224 COWL for CHIMNEYS, T. H. Rushton and J. C. Store, Hull.
23,225. TRUSS for PERSONAL WEAR, J. J. Sherman, Birmingham.
23,226. DRAUGHT EXCLUDERS for DOORS, H. Robinson, Manchester.
23.227. MOTOR VEHICLES, C. Y. Hopkins, London.
23,228. PHOTO-COPYING APPARATUS, R. W. Cunliffe, Manchester.
23,229. CONSTRUCTION of RAILS for TRAMWAYS, W. Hart, Sheffield.
23,230. CUPS and SAUCERS, E. Broughton, Manchester.
23,231. CYCLE SPEED GEAR, James Cycle Company, Limited, and F. A. Kimberley, Birmingham.
23,232. MOTOR CARS, Sir F. Ripley, Bart., and P. P. Craven, Hanley Castle, Worcestershire.
23,233. ELASTIC TIRES, H. Isherwood, Liverpool.
23,234. STAND for HOLDING WRINGERS, W. Martin, Glasgow.
23,235. AUTOMATIC BAG FASTENER, L. Forse, Yeovil, Somerset.
23,236. THIMBLES, F. Griffith, Birmingham.
23,237. PULP-BEATING ENGINES, J. White, London.
23,238. CARD for ADVERTISING PURPOSES, R. C. Brown, Glasgow.
23,239. TRAVELLING HOISTS, P. V. Appleby and J. W. Horner, Manchester.
23,240. BAR COUPLING LINK, S. J. Britton, Grimsby.
23,241. NOZZLE for VARYING the DIAMETER of a STREAM of WATER, A. Pordage, Edinburgh.
23,242. STONE PHOTO SETTING, J. H. Cardin, Matlock Bath, Derbyshire.
23,243. RAILS for MONO RAILWAYS, R. R. Thom, Troon, N.B.
23,244. TELESCOPES, J. Bonn and H. C. Fleming, London.
23,245. CONTINUOUS MANUFACTURE of CARDBOARD, H. D. Loria, London.
23,246. SEAMLESS HOSIERY, H. Hill, London.
23,247. SUPPORTS for BOOT-MAKING MACHINES, J. Gouldbourn, A. E. Jerram, and The British United Shoe Machinery Company, Limited, London.
23,248. DISPLAYING GOODS, T. Baxter, London.
23 249. ADVERTISING DEVICES, G. H. Hickson, London.
23,250. EDUCATIONAL APPLIANCES, J. H. Mason, London.
23,251. KEELS of SAILING BOATS, W. Ullmer, London.
23,252. TROUSERS HANGERS, C. Weber and R. Oeder, Dresden A8, Germany.
23,253. SECTION INSULATOR for ELECTRIC TROLLEY WIRES, T. E. R. Phillips, London.
23,254. TROLLEY HEAD for COLLECTING ELECTRICITY from ELECTRIC TROLLEY WIRES, T. E. R. Phillips, London.
23,255. EXTRACTING COPPER from ORES, S. J. Lett and Metalla, Limited, London.
23,256. VATS for EXTRACTING METALS from ORES, S. J. Lett and Metalla, Limited, London.
23,257. FOLDING OPERA GLASSES, P. Echter, London.
23,258. SUPPLYING ANTIFOULING COMPOSITIONS to STEAM GENERATORS, I. Smith, Nottingham.
23.259. RESCUING PERSONS FALLEN through ICE, A. Piller, London.
23,260. TELESCOPIC TABLES, R. Clayman, London.
23,261. FILTERS, J. Wilson, London.
23,262. LATHES, F. Trier, London.
23,263. CUTTING STONE, F. Trier, London.
23,264. AMBULANCE CART, J. R. Wood.—(*J. C. Wood*, ——.)
23,265. LIVE AXLES and WHEELS for AUTOMOBILE VEHICLES, F. Pilain, London.
23,2 6. ROLLER BLINDS, H. A. Cummins, London.
23,267. LOCK FASTENING, W. Jongebloed, London.
23 268. PNEUMATIC HAMMERS, J. W. Tierney, London.
23,269. MANUFACTURE of BLASTING CARTRIDGES, W. K. L. Dickson, London.
23,270. WEIGHING APPARATUS, L. E. Cowey, London.
23,271. MANUFACTURE of INSULATORS of GLASS, La Société Berger, Lord et Cie., London.
23,272. VARIABLE-SPEED DRIVING GEAR, E. Gessner, London.
23,273. MANUFACTURE of CARPETS, T. A. Gotobed, London.
23,274. EXPLOSION ENGINES, R. H. E. Philippart and A. G. Jardot, London.
23,275. MECHANICAL PIANO PLAYERS, H. T. Logan, London.
23,276. ELECTRICAL APPARATUS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
23,277. MATERIAL for PRODUCING FERMENTED LIQUORS, E. C. Schrottky, London.
23,278. LIQUOR DELIVERY PUMPS, A. Radovanovic, London.
23,279. ELECTRICAL RESISTANCES, H. Aron, London.
23,280. CARBURETTERS for INTERNAL COMBUSTION ENGINES, E. F. Bradley, London.
23,281. APPARATUS for CHECKING WORKMEN'S TIMES, L. W. Greaves, London.
23,282. VENTILATING MANHOLE COVERS, F. G. S. Ham, London.
23,283. PROTECTIVE DEVICE for PNEUMATIC TIRES, G. Desclée, London.
23,284. WHEELS for VEHICLES, D. Firth, London.
23,285. INDICATING the POSITION of SUNKEN VESSELS, T. Yates, London.
23,286. APPARATUS for COMPRESSING AIR, A. Clama, London.
23,287. FORMING RAFTS from LOGS of WOOD, H. Butenschön, London.
23,288. TRAINING YOUNG TREES, J. A. J. Chaligné-Massard, London.
23,289. FRAME for CARRIAGES, L. Lazerges, London.
23,290. MOULDS for CASTING METALS, N. Mennickheim, London.
23,291. RENDERING OBJECTS INSUSCEPTIBLE to PHOTOGRAPHY, J. Polak, London.
23,292. COLOURING of STONE, H. H. Lake.—(*Chemische Fabrik. Dr. Alb. R. W. Brand and Co., G. m. b. H., Germany.*)
23,293. AUTOMATIC MUSICAL INSTRUMENTS, H. H. Lake.—(*Sterling Company, United States.*)
23,294. PRINTING MACHINES, T. A. Middleton and C. E. Clift, London.
23,295. PAPER FEEDING APPARATUS for PRINTING PRESSES, J. W. Hoag, London.
23,296. GROWING SEEDS, F. Petersein, London.
23,297. PREVENTING SIDE-SLIP, T. G. Allen, jun., London.
23,298. DETACHABLE RIMS for RUBBER TYRES, C. Schmidt, London.
23,299. RESERVOIR PENHOLDERS J. de Meza, London.
23,300. SET SQUARES, G. Anderton, London.
23,301. NAIL-MAKING MACHINES, W. H. Dorman and A. P. Townsend, Birmingham.

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23,302. MAGNETIC MECHANISMS, L. H. Walter, London.
23,303. ATTACHING RINGS to CURTAINS, W. J. Chesters and E. Gormly, Liverpool.
23.304. ATTACHMENT for DETACHABLE TIRE TREADS, E. Stachl, Bristol.
23,305. WATER-TUBE STEAM BOILERS, G. Sinclair and G. Sinclair, jun., Glasgow.
23,306. CLEANING SILK, A. Mellor, Huddersfield.
23,307. CURTAIN RODS, C. H. Collins, Birmingham.
23,308. SEMI-SOLID LUBRICANTS, E. Berry, Manchester.
23,309. COALING VESSELS from RAILWAY WAGONS, J. Edge, Manchester.
23,310. HOT-WATER BOILER for GENERATING STEAM, J. Westwood, C. Barter, and T. Taylor, Birmingham.
23,311. STEAM BOILERS, R. L. Marriott, Southampton.
23,312. SPINDLES for SPINNING, F. G. Goodbehere.—(*H. Lawrence, United States.*)
23,313. CASTORS for BEDSTEADS, T. and A. E. Bourne, Birmingham.
23,314. MANHOLE CHANNELS for SEWERAGE, W. Brooke, Sheffield.
23,315. PICKLE JAR FRAMES, W. Beaumont and L. B. Dixon, Sheffield.
23,316. DRIVING RIDDLES of BARN FANNERS, J. Hanvey and J. Nesbitt, Glasgow.
23,317. STREET SWEEPERS and COLLECTORS, J. Thomas, Birmingham.
23,318. ENGINES for MOTOR BICYCLES, G. Pilkington, Birmingham.
23,319. MOTOR BICYCLES, G. Pilkington, Birmingham
23,320. BOBBINS for THREAD, H. R. Brunt and J. W. Swindells, Leek, Staffs.
23,321. DRAIN PIPES, F. E. Riddiford, Edington, near Birmingham.
23,322. COLLAPSIBLE COVERS for TRAMCARS, H. J. Thomas, Plymouth.
23 323. DEVICE for DISPLAYING ARTICLES, A. Silver, Liverpool.
23,3 4 LOCKING NUTS and WASHERS, H. D. Woolley, London.
23,325. COMPOUND BUTTER DISH, S. Rogers, London.
23,326. ADJUSTABLE WATER-CLOSET SEAT, E. Porter and C. Hamblin, Ipswich.
23,327. MANTLES for INCANDESCENT GAS LAMPS, M. Kay, London.
23 328. SLIDING SUPPORTS for OVEN SHELVES, J. W. and E. J. Crossland, and J. C. Dodgson, Sheffield.
23,329. CARBURETTING ALCOHOL, A. de Dion and G. Bouton, London.
23 330. CRANK SHAFTS, A. de Dion and G. Bouton, London.
23,331. CASE-HARDENED ARTICLES, A. de Dion and G. Bouton, London.
23,332. MECHANICAL PUZZLE, J. H. Birch and J. S. Foley, Birmingham.
23,333. GAS FIRE STOVES, Fletcher, Russell and Co., Limited, J. and W. R. Neil, Manchester.
23,334. SHAFT GUARD ARRANGEMENT, J. Duthie, Aberdeenshire, N.B.
23,335. OPERATING MACHINES, P. Wendelin, Charenton-Seine, France.
23 336. CONDENSERS, H. E. Burgess, Leytonstone, Essex.
23,337. APPARATUS for REGULATING TEMPERATURE, R. H. Haylock, Liverpool.
23,338. BOOTS, E. W. Sidwell, Glasgow.
23,339. DRIVING GEAR of MOTOR BICYCLES, H. King, Bournemouth.
23,340. UTILISATION of EXHAUST STEAM, E. J. Hess, London.
23,341. CINEMATOGRAPH FILM CUT-OFF, J. J. Wood, Manchester.
23,342. CASTORS, H. W. Cracknell, London.
23,343. SHARPENING RAZORS, R. O. Gräfe and S. Willett, London.
23,344. REVERSIBLE FEED GAUGES, T. Bakewell, London.
23,345. BAKING-WARE, J. Herzenberg and L. Pink, Berlin, Germany.
23,346. BAKING-WARE, J. Herzenberg and L. Pink, Berlin, Germany.
23,347. MUSIC STOOLS, C. H. Rawson and J. McKane, London.
23,348. LIGHTING and EXTINGUISHING LAMPS, D. Greig, S and J. Chandler, London.
23,349. ADVERTISEMENT SIGNS, H. H. Light, jun., London.
23,350. MACHINE for FIXING WRAPPERS, J. A. Horne, London.
23,351. JOINTING RUBBER TUBES, The Anglian Motor Company, Limited, and J. B. Robinson, London.
23,352. CARBONS for ELECTRIC ARC LAMPS, O. Hellstern, London.
23,353. CIGAR HOLDER, Balon, Limited, and S. Balon, London.
23,354. BICYCLE CRANKS and PEDALS, H. Cholmondeley-Pennell, London.
23,355. VENTILATION of BUILDINGS, G. F. Taylor, London.
23,356. NAIL DISTRIBUTING APPARATUS, J. Gouldbourn, and The British United Shoe Machinery Company, Limited, London.
23,357. TYPEWRITERS, G. S. Taylor, London.
23,358. ELASTIC-FLUID TURBINES, J. Gray.—(*J. Stumpf, Germany.*)
23,359. MONEY BOXES, R. H. Bishop and W. Down, London.
23 360. TURBINES, B. H. Morgan, London.
23 361. COVERING THREADS with GELATINES, V. Renard, London.
23,362. TIRES for WHEELS, J. Cooper, London.
23,363. CALCULATING APPARATUS, O L. Peard, London.
23,364. MANUFACTURE of ARTIFICIAL STONE, A. H., H., and G. van der Vijgh, London.
23,365. SWIVEL ROWLOCK, C. Weber, London.
23,366. MANUFACTURE of PERCUSSION CAPS, King's Norton Metal Company, Limited, T. A. Bayliss, H. W. Brownson, London.
23,367. MEANS for HAULING CABLES, Lacy-Hulbert and Co., Limited, and N. Dickson, London.
23,368. ORDNANCE, P. M. Justice.—(*The Driggs-Seabury Ordnance Corporation, United States.*)
23,369. ORDNANCE, P. M. Justice.—(*The Driggs-Seabury Ordnance Corporation, United States.*)
23,370. THRUST BEARINGS, The Hoffmann Manufacturing Company, Limited, and W. B. Mair, London.
23,371. STEAM GENERATORS, R. Goldschmidt, Liverpool.
23,372. INCANDESCENT GAS LAMPS, T. Steinicke, Liverpool.
23,373. PENCILS, A. Henniger, London.
23,374. BOTTLING MACHINES, H. C. Braun and H. E. Aspinall, London.
23,375. PROPULSION of LOCOMOTIVES, G. S. Granlund, Kingston-on-Thames.
23,376. HEATING FLAT IRONS, A. J. Boult.—(*C. Courrat, France.*)
23,377. DYNAMOS, I. Deutsch, London.
23,378. LOCK NUTS, C. E. Rancillac, London.
23,379. SULPHATE of AMMONIA SATURATORS, K. Zimpell, London.
23,380. SMELTING NICKEL ORES, La Société Electro-Métallurgique Française, London.
23,381. METAL BOTTLE STOPPERS, A. L. Weissenthanner, London.
23,382. METAL BOTTLE STOPPERS, A. Weissenthanner, London.
23,383. ROAD-CLEANING APPARATUS, R. A. Corbet and H. M. Delacour, London.
23,384. LIFTS, R. Waygood and Co., Limited, and H. C. Walker, London.
23,385. TRAVELLING CONVEYORS, I. Trolley, London.
23,386. COKING OVENS, P. P. A. St A. F. de Lachomette, London.
23,387. AUTOMATIC FIRE-ARMS, T. R. R. Ashton, London.
23,388. PNEUMATIC TIRE COVERS, E. S. Knight and H. O. Howorth, London.
23,389. REGULATING MOTIVE POWER, F. Bryan and H. S. Fearon, London.
23,390. DEVICE for HANGING PICTURES, W. A. Stacey, London.
23,391. CONVEYORS for CONVEYING COAL, G. Lister, London.
23,392. ALTERNATING CURRENT MOTORS, V. A. Fynn, London.
23 393. HEELS for BOOTS and SHOES, H. J. Medway, London.

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23,394. FINISHING the SOLES of BOOTS and SHOES, A. Keats, Stafford.
23,395. PLANING MACHINES, J. Miley and Craven Bros., Limited, Manchester.
23,396. CORNICE and CURTAIN RODS, T. S. Lucas, Birmingham.
23,397. SILENCERS for EXPLOSION ENGINES, A. E. Tucker, Birmingham.
23,398. FITTINGS for HOLDING DISPLAY RAILS, J. B. Bruce, Birmingham.
23,399. BACK-ACTION SWITCH, E. and A. Ellor, Manchester.
23,400. SECURING BRAKE WIRES to CYCLES, A. Smith, Birmingham.
23,401. BRAKE FITTINGS for CYCLES, C. T. B. Sangster, Birmingham.
23,402. MACHINE ATTACHMENTS for CYCLES, J. W. Hollyw od and T. J. Biggs, Frome, Somerset.
23,403. MOTOR VEHICLES, T. J. Biggs, Frome, Somerset.
23,404. JAR for STORING OINTMENT, A. E. Ferguson, Nottingham.
23,405. EXHIBITING PANORAMAS, G. Hill and A. M. Young, Manchester.
23,406. ARTIFICIAL LIMBS, A. E. Field, London.
23,407. STAYING METAL PLATES, J. M. McClellon, Boston, Massachusetts, United States.
23,408. TOY, J. Moore, Derby.
23,409. BOOTS and SHOES, D. Tomkies, Nottingham.
23,410. TIE FASTENERS, G. R. Lamont, Edinburgh.
23 411. PHOTOGRAPHIC LENS SHADES, C. H. Fryer, London.
23,412. DRAFT BOARDS for MILLING MACHINES, J. Bailey, Huddersfield.
23,413. EGG-CUP, W. Bunyar, Maidstone, Kent.
23,414. TRAJECTOMETER. T. Scully, Waterford.
23,415. SHUTTLE-PEGS, T. and H. Slinger and J. K. Redman, Nelson, Lancs.
23,416. DRAIN TRAP, G. Lewis and A. White, Chelmsford, Essex.
23,417. EARRINGS for UNPIERCED EARS, P. Bergna, Sunderland.
23,418. HOUSEHOLD UTENSILS, O. Barnewitz, Cologne, Germany.
23,419. EQUALISING GEAR for CHAIN-DRIVING MECHANISM, R. Dempster and Sons, Limited, and H. J. Toogood, Halifax.
23,420. CYCLE PUMP CONNECTION, R. A. Fletcher, Birmingham.
23,421. SEATING for VALVES, R. D. Scott, Warminster, Wilts.
23,422. CYCLE BRAKES, J. Taylor, London.
23 423. SECURING CANDLES in HOLDERS, J. H. Woodward, Birmingham.
23,424. GRINDSTONE TOOL-RESTS, J. H. Hetherington, Liverpool.
23,425. ELECTRIC LIVE-RAIL PROTECTIONS, J. Linkleter, Tynemouth.
23,426. RETTING FLAX, J. Shearer and C. O'Brien, Dundee.
23,427. COUPLING DEVICES, A. Woollen, L. Daniels, and J. Fearn, Sheffield.
23,428. BOOK COVERS, J. Kinkead, J. Livingstone, and W. J. Cohoon, Ballymena, Ireland.
23,429. SPINNING APPARATUS, G. O. Draper, Boston, Mass., United States.
23,430. FIRE-EXTINGUISHING APPARATUS, W. T. Ellison, Manchester.
23,431. PACKING FRUIT, J. J. Bisson, St. Sampsons, Channel Islands.
23,432. TRANSFERRING PHOTOGRAPHS on BLOCKS, E. Langheld, London.
23,433. RAILS for TRAMWAYS and RAILWAYS, J. Hill, London.
23,434. APPARATUS for PLAYING GAMES, J. Moffat, London.
23,435. SANITARY BUCKETS, T. F. and J. H. Braime, Leeds.
23,436. CONCENTRATION of ZINC from SULPHIDE ORES, H. R. Angel, London.
23,437. ENGINE PACKING, G. W. Beldam, Liverpool.
23,438. MAGNETO ELECTRIC APPARATUS, H. C. L. Holden, London.
23,439. RIBBON-BOW for the HAIR, W. Norling, London.
23,440. CHILD'S FEET REST for CYCLES, G. H. Giles, London.
23,441. BOILERS for WASHING PURPOSES, J. L. and J. L. Brobst, London.
23,442. FACILITATING CONVERSATION, S. Oppenheimer, London.
23,443. GATE HINGE, R. Temple, London.
23,444. MAKING INCANDESCENT GAS MANTLES, H. Hill, London.
23,445. COMBINED SINK, TUB, and BATH, J. Redfern, London.
23,446. DRAW PLATE BAKING OVENS, F. H. van Houten, London.
23,447. WIRE GUARDS for RAZORS, J. G. Brown, London.
23,448. TREATING LINSEED OIL, The British Oil and Cake Mills, Limited, and J. W. Pearson, London.
23,449. PRODUCTION of STATUARY, C. Bauer.—(*Marmorin Grabstein auf Ornamenten Fabrik Act.-Ges., Switzerland.*)
23.450. NUMBER INDICATOR for MOTOR CYCLES, A. Dunhill, London.
23,451. PRODUCING UNPOLISHED SURFACES on LEATHER, H. A. Nierhaus, Berlin, Germany.
23,452. INSULATION COILS of ELECTRICAL APPARATUS, O. B. Moore, London.
23,453. KNIFE-POLISHING MACHINE, F. Frieg, Berlin, Germany.
23,454. FEEDING WOOD-WORKING MACHINE, H. Walter, Berlin, Germany.
23,455. PLANT VASE, E. Pabst, Berlin, Germany.
23,456. TRANSPORTING CAR for FISH RESERVOIRS, G. Reinhardt, Berlin, Germany.
23,457. PARCEL HOLDER for CYCLES, F. Paschen, Berlin, Germany.
23,458. SIGHTING TELESCOPES, Fried. Krupp Act.-Ges, London.
23,459. FASTENING DEVICE for HARNESS, S. Nandor, London.
23,460. MANUFACTURE of UMBRELLAS, E. Howard, Southend-on-Sea.
23,461. PORTABLE ELECTRIC ALARM, R. F. Rowe and W. R. Bloye, Chelsea.
23,462 COFFIN NAME PLATE, H. J. Etcheils, B. Wallis, and C. P. Lawson, London.
23,463. DISINFECTANT COMPOUNDS, J. L. Hawliczek, Liverpool.
23,464. ONE-LEVER LOCKS, J. E. A. and H. A. Squire, Birmingham.
23,465. MAKING CARBONIC ACID GAS, F. Hunter, Beal, Northumberland.
23,466. INVERTED INCANDESCENT GAS LAMPS, A. Farkas, London.
23,467. BURGLAR-PROOF STRONG ROOMS, H. Turner London.

23,468. Pocket Typewriting Machines, G. Kostin, London.
23,469. Automatic Feed Regulators, W. Baker, London.
23,470. Paddle-wheel, G. A. Wiman and F. Schauman, London.
23,471. Apparatus for Recording Sales, C. Alexander, London.
23,472. Means for Propelling Ships, D. de Vasdényey, London.
23,473. Art of Decomposing Silicates, W. T. Gibbs, London.
23,474. Camera, M. Pautard, London.
23,475. Ball Bearings, Deutsche Waffen-und Munitionsfabriken, London.
23,476. Sight-feed Lubricators, J. N. Hochgesand, London.
23,477. Invisible Lacing, A. R. Colton, London.
23,478. Cravat Fastening, O. Imray.—(*Schuster and Baer Akt.-Ges., Germany.*)
23,479. Drilling Machines, S., C., and A. Richards, Birmingham.
23,480. Rotary Shafts, R., E., and A. Crowther, London.
23,481. Coin-freed Automatic Machines, A. Marsden, G. Stephenson, and the Theatre Sweetmeat Automatic Company, Limited, London.
23,482. Bending Glass, The Glas and Spiegel Manufactur N. and V. Kinon, London.
23,483. Bidet Apparatus, A. J. Boult.—(*F. O. Nather, Germany.*)
23,484. Goods Storage Cabinets, N. Struck, London.
23,485. Manufacturing Mosaic Tiles, L. Streuli, London.
23,486. Pipe Connections, C. Morehead, London.
23,487. Time-indicating Device, C. F. Shackel, London.
23,488. Apparatus for Sorting Nut Coal, W. Rath, London.
23,489. Governing the Speed of Shafts, L. W. Sterne, London.
23,490. Portable Tables for Railway Carriages, P. Storr, London.
23,491. Apparatus for Loading Wagons, P. Storr, London.
23,492. Manufacture of Artificial Emery, A. Gacon, London.
23,493. Machine for Washing Wool, W. McNaught, London.
23,494. Manifolding Mechanism, H. J. Halle and Elliott-Fisher Company, London.
23,495. Anti-slipping Device for Tires, R. H. Gayner, jun., Liverpool.
23,496. Advertising Lanterns, F. Koenig, Liverpool.
23,497. Ventilating Apparatus, A. Hendel, London.
23,498. Mufflers, W. H. Wheatley.—(*The Ford Motor Company, United States.*)
23,499. Closing Metal Boxes, T. Smith, London.
23,500. Jewellery Settings, A. H. Leiblus, London.
23,501. Apparatus for Turning Leaves of Music, J. W. Phillips, London.
23,502. Tent Pegs, J. H. Newman, London.
23,503. Parcelling Metal Plates, &c., N. Parham, London.
23,504. Sewing Machines, O. Robinson, London.
23,505. Strap Lock, H. Kitchin and A. Patten, London.
23,506. Locking the Doors of Railway Carriages, W. E. Larking, London.
23,507. Pneumatic Tires, W. W. Baverstock and E. W. Bennett, London.
23,508. Extracting Copper from its Ore, P. and A. Weiller, London.
23,509. Cooling Apparatus for Engines, G. F. Grotz, London.
23,510. Proportional Feeding of Solid Anti-fouling Agents for Steam Boilers, L. Jacquin-Barbier, London.
23,511. Typewriting Machines, R. W. James.—(*The Union Typewriter Company, United States.*)
23,512. Lamps for Motors, G. E. and A. R. Cragg, London.
23,513. Carburetters, A. de Dion and G. Bouton, London.
23,514. Exhibiting Advertisements, D. L. Chalmers, Liverpool.
23,515. Production of Stable Hydro-sulphites, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
23,516. Adjusting Vernier Ventometors on Rifles, G. B. H. Austin, Australia.
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23,518. Photographic Cameras, F. Pascal, Kingston-on-Thames.
23,519. Cutter-bars for Mowing Machines, P. R. J. Willia.—(*L. S. Ravelinson, United States.*)
23,520. Ball Check Unrefillable Bottle, A. Branth, London.
23,521. Two-needle Sewing Machines, R. Haase, Manchester.
23,522. Fire-grates, W. B. Agnesse, Birmingham.
23,523. Anti-vibrator for Incandescent Burners, J. Wolfson, Birmingham.
23,524. Grass-cutting Machines, S. K. Houghton, Birmingham.
23,525. Electrical Radiators, H. J. Dowsing, London.
23,526. Incandescent Gas Mantle Supports, W. McCallum, Port Dundas, North Glasgow.
23,527. Electric Cable Conductors, W. E. Hitch, Oxford.
23,528. Washers for Lock-nuts, G. B. and G. B. Wood, Sheffield.
23,529. Thawing of Frozen Meat, T. H. Gittins, Liverpool.
23,530. Toy Pistols, S. Brogden and G. Cockshutt, Halifax.
23,531. Mattresses for Bedsteads, J. T. Petford, Manchester.
23,532. Apparatus for Timing Pigeons, J. E. and G. H. Abell, Manchester.
23,533. Twine Holders, H. Kaye, Huddersfield.
23,534. Cash Check Tills, A. H. Gledhill, Halifax.
23,535. Variable Speed Gears for Cycles, F. Waite, Bradford.
23,536. Improvement Applicable to Motor Cars, R. F. Browne, Manchester.
23,537. Displaying Licence Cards on Vehicles, W. K. Kaye and H. Atkinson, Bradford.
23,538. Ventilating Hats, M. B. Meyer and C. Schaub, Manchester.
23,539. Clamps for Water Pipes, J. H. Dyer, Porth, Glam.
23,540. Device for Supporting Curtains, A. W. K. Neilson, London.
23,541. Making Uppers of Boots, F. G. Goodman, Northampton.
23,542. Improved Corset Busks, S. Simpson, Blackburn, Lancs.
23,543. Clip for Filing Documents, J. Graham, Glasgow.
23,544. Detachable Hinges, R. C. Ross, Dundee.
23,545. Apparatus for Cleaning Surfaces, J. E. L. Barnes.—(*Marine Construction Company, United States.*)
23,546. Social Games, R. J. Smith, Dublin, Ireland.
23,547. Construction of Fowl Houses, A. Clinch, Sittingbourne, Kent.
23,548. Means for Stoppering Bottles, R. J. Lecomte, London.
23,549. Stranded Wire Brake Safety, B. Kohn, London.
23,550. Knife Shoulder Cleaning Machine, A. L. Johnson, London.
23,551. Curtain Rods, J. T. Miller, Edinburgh.
23,552. Making Glass Bottles, A. Philippoteaux, Rheims, France.
23,553. Cattle Manure Receiver, W. A. Clarke, London.
23,554. Reamers, A. Chatwin and S. Slater, London.
23,555. Dovetailing Machines, W. B. Haigh and Co., Limited, and B. Shore, London.
23,556. Appliances for Transmitting Power, A. Hunnable, Ilford, Essex.
23,557. Prevention of Skidding in Vehicles, A. J. B. Legé, London.
23,558. Carpet Sweepers, P. Matter and B. F. Burk, London.
23,559. Diverging Electric Currents, E. Garsin.—(*G. Bogni, Italy.*)
23,560. Collapsible Seats, H. P. Schreiber, London.
23,561. Distribution of Air in Buildings, E. L. Joseph, London.
23,562. Apparatus for Washing Casks, R. Dresser, London.
23,563. Knock-down Shipping Cases, D. M. and R. W. Rundle, Missouri, United States.
23,564. Hat Pads, J. S. Weingott, London.
23,565. Motors for Washing Machines, G. E. Averill, London.
23,566. Brake Shoes, W. Fairweather.—(*The American Brake Shoe and Foundry Company, United States.*)
23,567. Electric Incandescent Lamps, A. W. Hill and J. Harrington, London.
23,568. Phonograph Record Cleaning Machine, F. M. Dearing and F. Moore, London.
23,569. Manufacture of Condensation Products from Tannine-like Substances, R. Lauch and A. Veswinkel, Berlin, Germany.
23,570. Portable Fire Mound for Grates, E. J. Owen, London.
23,571. Automatic Type-setting Laundry-marking Machine, T. J. Hume, Kansas City, Mo., United States.
23,572. Rotary Engines, S. J. Lawrence and H. Wesley, London.
23,573. Driving Belts, L. Leloup, R. Obernesser, J. and V. Tenthorey, London.
23,574. Massage and Lubricating Instrument, W. L. B. Hinde, London.
23,575. Combination Coal Box, Housemaid's Box and Cinder Sifter, R. F. Scotton, Portsmouth.
23,576. Restoring Ingredients to Flour, H. Roberts, London.
23,577. Shuttle Boxes for Rotary Box Looms, A. E., A., and G. Walker, London.
23,578. Odoriferous Compounds, E. Knoevenagel, London.
23,579. Self-operating Sugar Sifter and Graduator, A. G. Fischer, London.
23,580. Chain Wrenches, C. L. Perry.—(*J. H. Williams and Co., United States.*)
23,581. Washing Racks for Photographic Plates, W. H. Harrison, London.
23,582. Knife Cleaning Machine, J. S. Richardson, London.
23,583. Centering and Measuring Instrument, L. Eschenbrenner, London.
23,584. Pumping Apparatus, A. G. Waterhouse, London.
23,585. Detachable Umbrella Handles, B. Rothschild, London.
23,586. Propelling Ploughs, W. Reynolds, London.
23,587. Manufacture of Cement, I. C. Johnson, jun., London.
23,588. Music Portfolio, J. Norwood, London.
23,589. Power Brakes, L. Pfingst, London.
23,590. Power Brakes, L. Pfingst, London.
23,591. Embroidering Machines, A. Laubscher, London.
23,592. Washing Machines, F. Shippobottom, London.
23,593. Locating Punctures in Pneumatic Tires, R. and C. Tyler, London.
23,594. Boot Warmer, T. M. Cannon, London.
23,595. Gauged Brickwork, W. Hardie and G. King, London.
23,596. Depositing Ground Clay, E. Dickinson, London.
23,597. Process of Preparing Beer Wort, L. Rübsam, London.
23,598. Wrenches, R. G. Fling, London.
23,599. Looms, J. Guntz and A. Strüdel, London.
23,600. Furnaces, J. M. Petavy, London.
23,601. Apparatus for Handling Coal, W. R. Smith, London.
23,602. Free Wheel Hubs for Motor Cycles, G. L. C. Rivierre, London.
23,603. Optical Appliances, E. Barnes, London.
23,604. Electric Incandescent Lamps, E. Riethof and A. Basch, London.
23,605. Manufacture of Glass Vessels, P. T. Sievert, London.
23,606. Head Coverings, W. Buckler, London.
23,607. Tea Cups and Saucers, E. H. Winchcombe, London.
23,608. Die Press Printing Machine, T. R. G. Parker, London.
23,609. Water Meters, J. Y. Johnson.—(*W. Ferris, United States.*)
23,610. Atmospheric Gas Burners, E. Wood, London.
23,611. Forming Screw Stoppers for Bottles, R. Spinks, London.
23,612. Dynamo Electric Machines, R. M. Newbold, London.
23,613. Refrigerating Apparatus, Société Anonyme Westinghouse and M. Leblanc, London.
23,614. Apparatus for Sifting Chaff, S. B. Bamford, London.
23,615. Button Fastenings, A. Bryan, London.
23,616. Preserving Animal Food Substances, L. Fulda, London.
23,617. Automatic Cigarette Box, F. B. Goodyear, London.
23,618. Displaying Picture Cards, T. R. Lawrence, London.
23,619. Treating Corneous Substances, L. E. Nottelle and L. A. Leroux, London.
23,620. Coin-operated Vending Machine, L. B. Horrocks, London.
23,621. Hook Attachment for Belts, S. Stadler and L. Kölblinger, London.
23,622. Galvanic Batteries, P. Möllman, Liverpool.
23,623. Devices for Covering Jars, E. Eaton, Liverpool.
23,624. Water-heating Apparatus, H. Schaffstädt, Liverpool.
23,625. Self-opening Umbrellas, A. Seligstein, Liverpool.
23,626. Marker for Playing Card Games, F. Ceccarini, London.
23,627. Heels for Footwear, M. E., G. P. E. A., M. E., and E. M. Rénard, London.
23,628. Wheels, J. Butrulle and P. Macquelier, London.
23,629. Stringed Musical Instruments, O. Malms, London.
23,630. Lace Fastening for Boots, F. Bräuninger, London.
23,631. Blotters, H. Krandt, Hamburg, Germany.

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23,632. Motor Cycles, R. White, jun., London.
23,633. Iron Safes, A. Webley, Birmingham.
23,634. Draught Excluder, J. Inwood and J. Corry, Bradford.
23,635. Ageing Yarn, J. H. Walker.—(*P. Kestner, France.*)
23,636. Apparatus for Cleaning the Cards of Card Rollers in Cotton Mills, J. H. Walker.—(*P. Kestner, France.*)
23,637. Seat Framings of Cycles, J. B. Brooks and J. Holt, Birmingham.
23,638. Joinery Tool, S. M. Rawland, Liverpool.
23,639. Vent Pegs, A. Vickery, Birmingham.
23,640. Sewage Treatment, F. M. and H. Spence and P. Spence and Sons, Limited, Manchester.
23,641. Treatment of Certain Waste Waters, F. M. and H. Spence and P. Spence and Sons, Limited, Manchester.
23,642. Stamp Lifters, D. Smith, Wolverhampton.
23,643. Handles for Tooth Brushes, E. E. Crankshaw, Liverpool.
23,644. Machines for Stretching Leather, W. F. Finch, Liverpool.
23,645. Steam Cooking Appliance, W. McCaig, Paisley, Scotland.
23,646. Locking and Unlocking Doors, C. Robertshaw, Halifax.
23,647. Bleaching Cotton, T. Graham, jun., and F. Cope, Halifax.
23,648. Troughs for Kneading, A. R. Blakeway, Manchester.
23,649. Sewing Machines, G. Glaister, Manchester.
23,650. Non-slipping Cover for Tires, J. W. Gordon, Glasgow.
23,651. Yarn-spraying Apparatus, G. and A. Wray, Keighley, Yorks.
23,652. Non-collapsible Tire Device, J. Stubbs and A. Shann, Sheffield.
23,653. Vehicle-driving Mechanism, A. Dougill and J. Tangye, Bradford.
23,654. Wind-recording Instrument, C. Dalfs, Bournemouth.
23,655. Supporting Glass Advertisements in Tramcar Windows, Griffiths and Millington, Limited, and R. T. Simcock, Birmingham.
23,656. Apparatus for Testing Eggs, R. E. Oddy, Leeds.
23,657. Type-printing Frames, Schofield and Sims, Limited, and C. B. Camburn, Leeds.
23,658. Toasting Rack, J. T. Walker, London.
23,659. Steam-driven Air Pumps, W. Weir, London.
23,660. Looms, A. W. Anderson and W. Forster, Dundee.
23,661. Dynamo Electric Machinery, S. T. Webster, Liverpool.
23,662. Tramway Destination Indicator, A. G. Wild, Sheffield.
23,663. Furnaces for Melting Steel, N. K. Peace, Sheffield.
23,664. Rain-intercepting Devices for Umbrellas, D. France, Manchester.
23,665. Steering Vessels, H. H. MacTaggart and R. G. Scott, Glasgow.
23,666. Motor Vehicles, G. D. Wallis, Nottingham.
23,667. Shuttles for Looms, T. C. Keay, Glasgow.
23,668. Thread Guides, J. Burtinshaw, Manchester.
23,669. Adjustable Bed Cradles, F. Round, Birkdale, near Southport.
23,670. Ashpan, F. S. Holton, London.
23,671. Facias, T. F. Davies and A. E. and C. F. Morris, London.
23,672. Life-saving Apparatus for Tramcars, P. R. S. Willis.—(*K. Mooring, United States.*)
23,673. Silencers for Internal Combustion Engines, H. J. Lee and A. Preen, Coventry.
23,674. Holding Invoices, A. M. Lipman, Dover.
23,675. Method of Treating Distillation Gases, H. Blau, London.
23,676. Combined Combs and Hair Pads, J. H. B. Dawson, London.
23,677. Self-adjusting Motor Trembler, E. Aron.—(*B. Langumier, France.*)
23,678. Boot Frames, M. Theis and J. D. Castellani, London.
23,679. Composition for Hulls of Ships, F. E. Dunnett, London.
23,680. Treating Tar Oils, Rud Rütgers Chemische Fabrik für Teerprodukte, London.
23,681. Stocking Holder, H. Frank and M. Herz, London.
23,682. Collars, B. J. B. Mills.—(*P. Francois, France.*)
23,683. Lamps for Inverted Incandescent Mantles, E. J. Shaw, London.
23,684. Novelty in Posters, J. Walker, Croydon, Surrey.
23,685. Electric Projecting Lamps, L. Kamm, London.
23,686. Acetylene Lamps and Burners, L. Kamm, London.
23,687. Portable Search Lamps, L. Kamm, London.
23,688. Carburetters, V. M. Crawford, London.
23,689. Internal Combustion Engines, V. M. Crawford, London.
23,690. Variable Speed Gears, V. M. Crawford, London.
23,691. Steering Gear for Motor Cars, V. M. Crawford, London.
23,692. Hubs for Motor Vehicles, V. M. Crawford, London.
23,693. Silencers for Gas Engines, V. M. Crawford, London.
23,694. Seats for Motor Vehicles, V. M. Crawford, London.
23,695. Wire Hat Frames, W. M. Jamason, Boston, United States.
23,696. Electric Submarine Cables, J. A. I. Dearlove, London.
23,697. Tires for Motor Vehicles, I. Clifford, London.
23,698. Rotary Engines, J. Hartig, London.
23,699. Umbrellas, A. A. Revel, London.
23,700. Brake and Clutch Mechanism, C. A. Arbey, London.
23,701. Locking Convertible Chairs, E. Vaughan, Birmingham.
23,702. Pneumatic Tires for Motor Vehicles, E. C. F. Otto, London.
23,703. Heels of Boots, A. Norreys, London.
23,704. Castor for Chairs, S. Lee, London.
23,705. Low-pressure Steam Heating Apparatus, F. Kaeferle, London.
23,706. Propelling Ships, J. C. Kunst, London.
23,707. Travelling Railroad Crane, H. Zutt, London.
23,708. New Fabric, J. Elster, London.
23,709. Pneumatic Tires, W. Marsha l and W. Oates, London.
23,710. Protectors for Rifles, C. Heseltine, London.
23,711. Undergarment, B. Kempner, London.
23,712. Variable Speed Gearing, S. Knight, London.
23,713. Dissolving Gold, A. Dupré.—(*F. W. Dupré, Germany.*)
23,714. Locomotives, C. W. Paget, London.
23,715. Automatic Steam Generators, H. Tallgren, Liverpool.
23,716. Preventing Sparking of Commutators, Allgemeine Elektricitäts-Gesellschaft, London.
23,717. Plates and Dishes, W. Mountford and W. Machin, London.
23,718. Aerating Liquids, W. Hucks and W. Hucks, jun., London.
23,719. Rotary Motors, F. A. Jones, London.
23,720. Erection of Concrete Walls, A. J. Boult.—(*J. S. Metcalf Company, United States.*)
23,721. Rotary Motors, J. H. Barker, London.
23,722. Cases for Menthol, V. Pappenheim, London.
23,723. Non-refillable Bottles, E. G. A. Bertin, London.
23,724. Railway Signalling, G. M. Schreiber, London.
23,725. Feed-water Cleaners, A. Musnicki, London.
23,726. Rheostats, C. Wirt, London.
23,727. Transforming Oils into Soap, M. Kuess, London.
23,728. Envelope Making Machines, H. W. Birdsall, London.
23,729. Condensation Products, H. Lüttke, P. Arndt, and E. Löwengard, London.
23,730. Machines for Coating Plates, F. J. Taylor, London.

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23,731. Flash Lamp, M. Diessner, Glasgow.
23,732. Springs, A. Reid, London.
23,733. "Electoris," F. Mackenzie, Edinburgh.
23,734. Water Candles, H. Botche, Manchester.
23,735. Sewing Sections of Books, A. T. and H. Elsworth, Settle.
23,736. Vertical Steam Generators, R. L. Marriott, Southampton.
23,737. Fuel Combustion, J. L. Fawcett and W. Fargus, Hull.
23,738. Wheels for Vehicles, T. D. Stagg, Hull.
23,739. Self-closing Valves or Taps, W. E. Wheat, Nottingham.
23,740. Brushes, A. and J. P. Macdonald, Birmingham.
23,741. Painters' Burning-off Torches, A. H. Allen, Birmingham.
23,742. Making Lace, T. I. and T. S. Birkin and T. Anderson, Nottingham.
23,743. Umbrella Stand, F. Hardwick, Derby.
23,744. Water Mattress or Cushion, J. Sossick, London.
23,745. Calendars, O. N. Boll, Liverpool.
23,746. Threshing Machines, S. Sutton, Stoke-on-Trent.
23,747. Treating Sewage, J. Bolton and M. W. Mills, Manchester.
23,748. Recording Speed Indicators, H. Brooker, Waltham Cross.
23,749. Boots, Shoes, and Slippers, J. E. Audsley, Glasgow.
23,750. Loom Motion, J. Wojciechowski and R. Pluzanski, London.
23,751. Bottles, J. Dumbelton and G. B. Smith, Birmingham.
23,752. Chair Holdfast, W. Henderson and L. H. Burton, Stockton-on-Tees.
23,753. Passenger Transfer Tramway Tickets, J. Jack, Edinburgh.
23,754. Lubricating Press, P. A. Hoppe and H. J. Eggers, Hamburg, Germany.

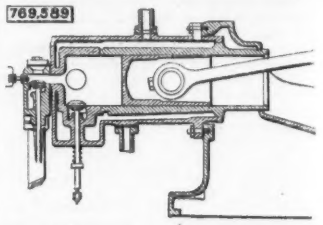
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

769,589. Gas or other Internal-combustion Engines, *B. Clerk, Eccharst, England.*—*Filed May 14th*, 1904.

Claim.—In an internal-combustion engine the combination with the cylinder and means for supplying a combustible mixture thereto, of means for supplying

769,589

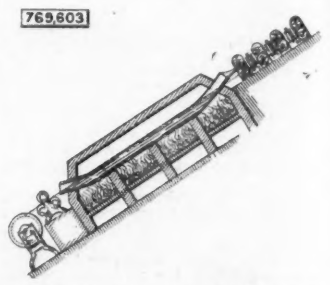


steam under pressure to said cylinder during the compression stroke of the piston, substantially as described.

769,603. Manufacture of Iron or Steel Wire, *F. Forsberg, Sandviken, Sweden.*—*Filed March 25th*, 1903.

Claim.—The herein-described improvement in the art of forming wire from a rod of iron or steel, which

769,603



consists in first heating said rod, and then, while it is hot, subjecting it to alternate rolling and roll-drawing operations simultaneously applied at different parts of the rod.

769,623. Locomotive Boiler, *J. Muhr, Dunkirk, N.Y.*—*Filed March 4th*, 1904.

Claim.—The combination with a locomotive boiler and its smoke-box, of a stack extending into the smoke-box, an exhaust nozzle connected with the

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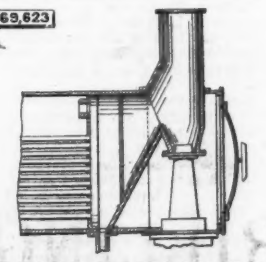
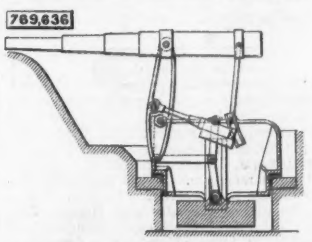


lower end of the stack and forming therewith a continuous laterally closed passage, and a conduit leading directly from the flue sheet of the boiler into the side of the stack above the exhaust nozzle.

769,636. Carriage for Disappearing Guns, *F. Rauenbeuger, Essen-on-the-Ruhr, Germany.* — *Filed May 4th*, 1901.

Claim.—(1) A disappearing gun mount comprising a barrel carrier and a counterbalance weight controlling the barrel carrier through a toggle-joint; the weight being directed in a vertical straight guide and the fixed pivot of the toggle joint being vertically above the connection of such toggle joint with the weight. (2) In a carriage of a disappearing gun, the combination of a two-armed barrel carrier, having a fixed pivot,

769,636



a balance weight for returning the barrel to firing position, a straight-lined vertical guide fixed to the frame of the carriage, a toggle joint having one end pivoted to the frame of the carriage, and the other to the balance weight, and means establishing articulated connection between the lower end of the barrel carrier and the knuckle of the toggle joint, the arms of the toggle joint and the lower arm of the barrel carrier being half as long as the upper arm of the barrel carrier.

THE INTERNATIONAL ENGINEERING CONGRESS AT ST. LOUIS.

No. II.*

LIGHTHOUSE ENGINEERING.

Another series of communications made to this Congress consisted of three papers in connection with lighthouses, which may be considered as authoritative statements of the present condition of that important branch of engineering in the countries of Great Britain, France, and the United States. The papers were written by Mr. T. Matthews, Engineer-in-chief to the Trinity House; M. Ribière, Ingéneur-en-chef de Service Central des Phares, Paris: and Lieutenant-Colonel Lockwood, Engineer Secretary to the United States Lighthouse Board.

A careful and comparative study of the papers is calculated to leave the impression on the mind of anyone who possesses even a superficial knowledge of the subject that, however far in advance of the Old World our American cousins may be in certain branches of science and engineering, they are not pre-eminent in lighthouse work. On the other hand, it is still the French engineers who are in the van of progress.

The fact should be noted that within the last quarter of the nineteenth century nearly all important improvements in the design of lighthouse apparatus originated in France. We have only to take the improvements described by Mr. Matthews as having been recently introduced in the service of the Trinity House to find that these have their origin in Paris. The incandescent petroleum vapour burner, adopted by the Trinity House in 1902, is but a variation upon the same type of burner used in the French lighthouse service for the past five years.† The mercury float now universally adopted for new lighthouse apparatus was in use in France ten years before it was adopted in this country at Lundy. The reduction in the periods of flashing lights which has been so pronounced of late years was the outcome of the investigations of M. Bourdelles and other French engineers. The system of quick flashes at short intervals, although in general use in the French service nearly fifteen years ago, has only just succeeded in establishing itself in the Trinity House service.

To refer in detail to the several papers, taking that of Colonel Lockwood first. The author states that, among the more important rock and reef towers now in course of construction by the American Board, are the granite structures at the Graves at the entrance to Boston Harbour and at Ram Island Ledge at the entrance to Portland Harbour. The restricted area of the ledges and the exposed situations render construction in these positions difficult.

Colonel Lockwood's references to light-vessels are of much interest, particularly when one is able to compare them with the details contained in the papers presented by the English and French engineers. In former days, when very few light-vessels exceeded 300 tons displacement, but little difficulty was experienced in connection with their moorings. During recent years, however, there has been a great tendency to increase the size and, consequently, the displacement of the vessels, with the result that accidents due to the dragging and parting of moorings have become more frequent. The ground tackle adopted for the large light-vessels off the American coasts consists of large mushroom anchors from 2½ to 3½ tons weight, with mooring chains passing through hawse pipes in the centre of the stem, and secured—in the case of the more recent vessels—by an automatic steam riding windlass, designed to relieve the stress on the chain in rough weather. In addition, the more modern vessels are provided with steam propelling machinery, by which they can further aid in relieving the stress at their moorings, and for use in case of their being driven off their stations. In the English service, the case of a light-vessel dragging her anchor was, at any rate in the old days of small craft, a most infrequent occurrence, and did not occur once in twenty years. The cost to the United States Lighthouse Board of a modern lightship complete in all respects, including propelling machinery, must be very much higher than in the case of the older and much smaller vessels.

Notwithstanding the great size and elaborate construction of light-vessels now in use on the coasts of the United States, it would appear from Colonel Lockwood's paper that their illuminating apparatus leaves something to be desired. The beam intensities emitted by the old-fashioned revolving catoptric apparatus of Trinity House light-vessels with mineral oil burners range, as a rule, from 8000 candles to 12,000 candles, some exceeding the higher limit. The new "Spurn" light-vessel apparatus is of 20,000 candle-power. Again, the type of dioptric flashing apparatus adopted in recent years by the French Lighthouse Service at certain stations, and illuminated by oil gas, gives intensities which are stated to approach 33,000 candles. The latest French vessel equipped with such an apparatus, the Sandettie, is described in M, Ribière's paper. The following are the principal particulars:—Length, 114·8ft.; breadth at water-line, 20·5ft.; depth, moulded, 16·7ft.; draught—including a keel 3·3ft. deep—15·1ft.; displacement, 341 tons. The vessel carries a crew of eight men. It is to be observed that the displacement of this vessel is but a little over half that of one of the modern United States light-vessels of 600 tons displacement. The apparatus of the latter, with electric lamps, has a beam intensity of only 1800 candles. The construction of the Sandettie is the outcome of a long series of observations and experiments on the part of the French Lighthouse Service, undertaken with a view of improving both the stability of the ship and the illuminating apparatus. The rolling of the vessel has been reduced:—(1) By the suppression of all synchronism between the period of the vessel's oscillations and that of the waves; (2) by the use of deep projecting main and bilge keels; (3) by lowering the centre of gravity of the vessel.

The optical apparatus consists of four fourth-order lens panels revolving on a system of ball bearings, carried in a Cardan suspension frame, which permits of the optic remaining practically in a vertical position notwithstanding the rolling of the ship. Experiments have shown that with this type of suspended optic the deflections from the vertical do not exceed 5 or 6 deg. The illuminant is compressed oil gas used in connection with an incandescent mantle. The gas is stored in large cylindrical steel holders placed in the hull of the vessel, the capacity of which is sufficient to supply the illuminating apparatus for many weeks. The light-vessel is provided with a compressed-air fog siren driven by a steam motor.

The vessel, after undergoing a series of trials in various situations off the French coast, was anchored at her final station near the entrance to the North Sea, off the Sandettie Bank, where the depth at low water is 75ft., in December, 1903. The experience gained by the French lighthouse authorities in connection with this vessel and her predecessors has been of the most satisfactory character.

The Trinity House, benefiting by the experiments and improvements of our French neighbours, have determined to construct a light-vessel apparatus having a fixed lantern in place of the old-fashioned movable lantern with reflectors hung in gimbals. The new fixed lantern will shelter a dioptric apparatus somewhat similar to that in use on the Sandettie. There is also being constructed for the Trinity House an experimental light-vessel of small size, similar to the Talais, a French vessel of the Sandettie type, but of earlier date, which will have oil gas as the illuminant. It is intended to place this craft at first at an inshore station, and gradually to moor her at more exposed positions, with a view of obtaining experience of the new type. The action of the Trinity House in connection with these vessels is another example of the tardy adoption of improvements originating in the French service.

Reverting to the illuminating apparatus adopted for light-vessels by the United States Board, Colonel Lockwood states that in modern vessels this consists of a series of three or four small-lens lanterns suspended at the masthead. In the case of electrically-illuminated vessels, the aggregate candle-power of the group is about 1800, while those lit by oil have a power of only 540 candles. The majority of the electric lights are occulting, but, with a few exceptions, the oil-illuminated apparatus show fixed lights. This description, when compared with the brief accounts, given above, of light vessels on this side of the Atlantic, can hardly be regarded as reflecting credit upon the United States administration. It would seem to be a striking anomaly that in America it requires a 600-ton vessel with steam propelling machinery to exhibit a light of 540 candles, while in France, and even in England, vessels of half the displacement exhibit lights of 20,000 to 30,000 candle-power.

Both M. Ribière and Mr. Matthews describe the incandescent petroleum vapour burners now in use in their respective services. The introduction of incandescent petroleum lighting must be regarded as one of the most marked improvements in connection with lighthouse engineering in recent years, and the Elder Brethren are to be congratulated upon their recent adoption of the system. In the case of the Matthews burner, oil is supplied to a vaporiser under pressure of about 53 lb. per square inch, the pressure being obtained by means of a small air receiver attached to the oil chamber, which is provided with the necessary strainers, valves, gauges, &c. The vaporiser consists of a coiled brass tube entirely enclosed within a metal hood over the mantle. From this coil the gas is conveyed to the base of a vertical pillar, whence it is led into a small box or chamber, and allowed to escape through a fine nipple into a brass vertical tube or column in which, and immediately above the nipple, four ports are formed to admit air. The gas and air then ascend together, passing though a film of fine brass gauze, into a mixing chamber, where a cone in the centre diverts the stream to the outer edge of the burner and on to the walls of the incandescent mantle which surrounds the same. The working intensity obtained with a No. 7 Welsbach mantle is 1250 candles, the oil consumption being one pint per hour. The oil used is ordinary lighthouse paraffin flashing at about 143 deg. Fah.—close test. A striking illustration of the advantage obtained by the use of this form of illuminant is given by Mr. Matthews, who quotes the Eddystone biform apparatus which, with the old concentric six-wick burners consuming 2500 gallons per annum, gave a total intensity of 79,250 candles, but now under the new *régime* emits a flash of 292,500 candles, the oil consumption being nearly halved.

Mr. Matthews has also devised a triple mantle burner having a large effective local diameter, for use in connection with the several hyper-radial lenses and first order occulting lights existing in the service. The service intensity of this burner is 3300 candles, with a consumption of three pints of oil per hour. By such an arrangement it is inevitable that the intrinsic brightness of the flame, which is a desideratum in the design of lighthouse apparatus, must be seriously reduced, and it is to be hoped that its use will be restricted to lenses of great focal distance. It is a matter for question whether more satisfactory results would not have been obtained by the use of burners with large single mantles of 85 mm. and 100 mm. diameter, such as have been adopted in other services.

The burner adopted by the Trinity House is generally similar to that used in the French service—as a matter of fact it is a modification of the latter—differing only in details, the most important being in the design of the vaporiser, which in the original French type consists of a single tube, in the form of an inverted U, placed over the mantle. This tube, like the Matthews coil and hood, but in a less degree, possesses the objection of obstructing the passage of light in certain directions. The French burner is usually made in two sizes to take mantles of 55 mm. and 85 mm. diameter respectively. M. Ribière states that an intrinsic brightness of 3 carcels per square centimetre is obtained with the burners, as against from ·35 carcel to 1·18 carcels with the old concentric wick burners. With his incandescent acetylene burner, used at Chasiron, M. Ribière has obtained 6 carcels per square centimetre.

The Chance burner, no mention of which is made in any of the papers, although many are in use, has been designed to overcome the objections to the external vaporiser, the oil being vaporised in a separate closed chamber, placed under the mantle and burner, the tube being heated by means of a subsidiary burner, drawing its supply of gaseous oil from the same source as the main burner. The total intensities obtained with the burner are upwards of 1250 candles with 55 mm. and 2200 candles with 85 mm. mantles. Colonel Lockwood's experiments in incandescent illumination do not appear to have been attended with the satisfactory results chronicled by the other authors. The Kitson lamp, one of which was experimented with at the United States general lighthouse depôt, is, in its ordinary form, unsuitable for lighthouse use, and this fact probably explains the decision of the United States authorities not to adopt it for service. That other forms of incandescent apparatus are suitable and thoroughly efficient is now unquestionable, and the failure of the United States Board to utilise the improved illuminant is to be regretted. Mr. Matthews chronicles the lighting of the Monkstone Beacon by oil gas in the Bristol Channel as the first instance of its kind on the English coast. It should be pointed out that for many years scores of unattended beacon lights illuminated by oil gas on the Pintsch system have been in service in Scotland, France, America, and other parts of the world.

By far the most interesting matter in any of the papers under review is that concerning the conditions governing the permissible duration of flash contained in M. Ribière's contribution. As a result of recent extensive experiments, $\frac{3}{10}$ second has been adopted by the French authorities as the minimum duration for white flashing lights. If shorter flashes are used, it is found that the reduction in duration is attended by a corresponding, but not proportionate, diminution in effective intensity. In the case of many electric flashing lights the duration is of necessity reduced, but the greater initial intensity of the flash permits of this loss without serious detriment to efficiency. Red or green requires a considerably greater duration than do white flashes. It will be seen, therefore, that the French authorities have somewhat modified their former minimum of $\frac{1}{5}$ second flash. In view of these facts, the new Lizard light, which now exhibits flashes of ·13 second duration at intervals of 3 seconds, is an anomaly in a service the members of the governing board of which had until quite recently been strenuous advocates for and defenders of the old system of lengthy flashes.

Colonel Lockwood devotes much space to a discussion of the system of flashing lights known by the name of its introducer into the States—Captain Mahan, late Engineer Secretary to the United States Board. The system is not new, and has been often discussed. Colonel Lockwood, however, does not add materially to our knowledge of the subject, and the limited space at our disposal precludes a criticism of his arguments.

Mr. Matthews gives descriptions of two towers erected by the Elder Brethren during his tenure of the office of Engineer-in-chief to the Trinity House. The one, that erected near the foot of Beachy Head, and completed in 1902, has on several occasions been illustrated in these columns; the other, built ten years ago at Spurn Point, to replace a fine old structure of Smeaton's design almost contemporaneous with the old Eddystone tower. The design of the new tower, an ordinary land structure, presents no unusual feature, and we fail to see why Mr. Matthews should have cited this building and its somewhat antiquated type of hyper-radial apparatus on a roller carriage, differing but little from apparatus in use over a quarter of a century ago, as typical of modern practice.

Mr. Matthews describes a carbon wick burner which he has devised for use at the East Usk lighthouse, capable of burning "without attention throughout the longest night." We quite fail to see any exceptional advantage to be derived from the use of such a burner, or that its adoption is of sufficient general interest to be chronicled as an example of modern improvement. For years there have been wick and other burners in use fulfilling this very modest requirement, and even carbon wick burners have been on the market for a considerable period. The well-known French "permanent lights,"* again described by M. Ribière, burn without attention for a month or more consuming ordinary petroleum.

* No. I. appeared November 11th.

† "Lighthouse Engineering at the Paris Exhibition."—The Engineer, June, 1900, to March, 1901.]

* "Lighthouse Engineering at the Paris Exhibition," March 15th 1901.

PASSENGER TRAFFIC ON INDIAN RAILWAYS.

The practical working of all railways may be regarded as the executive department, separate and distinct from the administrative. It comprises the organisation, the management, the regulating, and the development of the traffic. It must be careful of the wants and customs of the public, and keep a watchful eye upon the economy of the *régime* which it institutes, governs, and maintains. All traffic consists principally of passengers and goods, and each must be dealt with on lines which do not admit of a double interpretation. The question of speeds—we do not mean "scorching"—is inseparably interwoven with the subject of passenger traffic. It is not to be expected, nor would it be fair to demand, that the speed of our Oriental railways should equal that adopted in the western portions of our dominions. It might, however, with advantage approximate to it considerably closer than it does at present. There are four well-defined classes of speed for trains upon the lines in Hindustan. The fastest is that of the mail trains belonging to the

Great Indian Peninsula and the East Indian systems. The average speed of this "Postal Special" is 33¼ miles per hour, and the maximum 34½. In the second category, the hourly rate of speed does not surpass 31½ miles, a velocity which, for ordinary trains in the third division, is reduced to a bare 14 miles. Under the fourth head are included the branches which are run over at the rate of eight miles per hour. This last-mentioned class must not be judged too harshly. We have travelled over some of the English country branch lines, and, allowing for the different conditions prevailing, they are comparatively but little better than their Indian congeners. It is now half-a-century since the introduction of railways into our great eastern empire, and from a general point of view it might have been reasonably anticipated that more progress would have been made in this particular detail, so intimately connected with the comforts and occupations of travellers.

It is probably not generally known that the average number of passengers in a train is greater in India than in any other country in the world. A reference to the accompanying Table I. will enable the reader to judge of the manner in which our great Eastern railway systems contribute their quota to the totals arrived at.

TABLE I.

Name of railway.	Average number of passengers in a train.				Total.
	1st.	2nd.	Inter.	3rd.	
Bengal-Nagpur...	0·87	3·09	6·40	232·33	242·69
Bombay, Baroda, and Central India	1·95	12·66	27·55	185·58	227·74
East Indian	1·35	4·43	14·69	207·93	228·40
Great Indian Peninsula ...	2·08	8·88	14·90	128·55	154·41
Madras	1·90	6·62	0·85	192·94	202·31
North-Western...	1·35	4·36	14·27	177·19	197·17
South Indian	0·85	3·51	—	262·93	267·29
Southern Mahratta.. ...	1·14	3·78	—	172·63	177·55

One of the distinguishing characteristics of Indian railways is the addition of a fourth or intermediate class of carriages. This four-fold provision is not universal. The lines in Southern India, as indicated in Table I., do not use the intermediate class, nor has it been introduced into the neighbouring territory of Burma, in the possessions under English rule. The additional accommodation injuriously affects the deadweight of the trains, and also, consequentially, the working expenses. It will be seen from Table I. that upon the Madras Railway this fourth class of carriage is credited with the insignificant comparative value of 0·85. It is true that with this exception the scheduled numbers for the intermediate class greatly exceed those for the first and second, but, at the same time, they fall immeasurably below those obtaining in the third class. It should be here observed that upon all the Indian railways, similarly to those in other countries, it is the third-class passengers who contribute the bulk of the revenue accruing from that department.

TABLE II.

	Gauge.					
	Broad, 5ft. 6in.		Metre.		Broad and metre.	
First	1·48	... ...	0·88	... ...	1·31	
Second	5·45	... ...	3·45	... ...	4·86	
Intermediate...	13·64	... ...	3·59	... ...	10·65	
Third	173·65	... ...	217·37	... ...	188·66	
S.T....	4·56	... ...	0·63	... ...	3·39	
Total	198·78	... ...	225·92	... ...	206·87	

Table II. gives the relative average distribution of passengers for each class in each train for the year 1901, with reference to the different gauges adopted in the country. In the same period, the number of third-class passengers, exclusive of season-ticket holders, amounted to 170½ millions, against 9½ millions of all the other classes put together.* The question of reducing the number of the different classes of carriages deserves careful consideration. While admitting the expediency of such a measure and the power to put it in force, it should be kept in view that some doubt may be fairly expressed respecting the advisability of its general application. It has been stated that because a few railways in the south of India and elsewhere, to which we have already referred, retain only three classes, the rest of the great lines could very well afford to do the same. This argument is more specious than real, and is, in fact, reasoning from the particular to the universal, against which we are warned.

Heavier and more powerful engines, heavier carriages, and heavier wagons, mark the order of sequence which attends the progress and development of modern rolling stock. A very appreciable portion of the traffic upon Indian railways is transported in mixed trains. This mode of transit is frequently unavoidable. It occurs in certain of the poorer districts in which the amount of traffic is not sufficient, either in quantity or quality, to warrant the running of separate passenger and goods trains. Any discontinuance of these trains would result in a considerable addition to the working costs, which would far outbalance the chief objection to them, that of low speed.

The employment of bogie carriages on Indian railways has made but very little progress hitherto. It is difficult to understand how it ever will, so long as the building of the old four-wheelers continues. The number of these obsolete old vehicles dispersed over the whole railway system is legion. The task of substitution will occupy many years before even the more important trains are supplied with the new type. There are at present 14,000 miles of new lines projected, and a portion of the mileage under construction in Hindustan. It may be reasonably presumed that these new lines, or at least as many of them as belong to the standard gauge, will be equipped with bogie carriages. It must be borne in mind that in their case there are no four-wheelers to be got rid of, or shunted on to subsidiary tracks, loop lines, and branches. There remains the possible alternative, that the new lines might, for economical reasons, relieve some of the older companies of part of their antiquated rolling stock, which the latter could replace by the bogie pattern. The superior comfort and convenience for the passenger, and the less cost of working of the newer vehicle, are now so universally recognised throughout both Europe and America, that in all probability the suggested alternative would not be made use of.

A few particulars regarding the relative dimensions of the carriages in use upon the different gauges of Indian railways, and those existing on the railway systems in America and on the European continent, will not be inappropriate to the subject of our article. Taking the 4ft. 8½in. gauge as the standard of comparison, the clear width of the English carriage is 8ft. 6in. In America it is 10ft., and 10ft. 6in. on the Continent for the same gauge. The Indian standard gauge is 5ft. 6in., so that calculating proportionally the comparative widths of the Indian carriages, relatively to the same dimension of those of English, American, and continental lines, should be 9ft. 10¾in., 11ft. 8½in., and 12ft. 3in. But the actual width of the Eastern carriages is only 9ft. 6in., which is 6in. less than that of the American, 1ft. less than that of the continental, and but 1ft. more than that of the English vehicles. Obviously, therefore, as Mr. Robertson remarks, the railways in India have never obtained the full benefits of their wider gauge, and are working about 22½ per cent. under power. Reasoning analogously, the relative widths of the metre gauge passenger rolling stock will be found to be 5ft. 11in., 6ft. 11¼in., and 7ft. 4in. But these carriages measure transversely 7ft. 9in., or but 9in. less than those on the English railways, and are, therefore, proportionately of a higher carrying capacity than those of the continental lines. The same relative and economic ratio holds also, but to a rather higher degree, in the widths of the carriages belonging respectively to the metre and the Indian standard gauges. It should be stated that in our review of the actual and proposed dimensions of this class of vehicles, it is not implied that valid reasons did not exist for so apportioning the former. It would, for instance, be impossible under existing conditions, unless an unwarrantable expenditure were incurred, to adopt the assumed maximum breadth, 12ft. 3in., of carriage on the 5ft. 6in. gauge. The bridges, tunnels, and other constructive works are not sufficiently large to permit of the innovation.

It is satisfactory to be assured that the whole question is engaging the serious attention of the Indian Government. The enormous population of our great Eastern Empire, its trade, traffic, commerce, industries, and development, need and deserve a complete remodelling of a system of internal communication, which may well be somewhat out of date after a service of half a century.

* "Report of the Administration and Working of Indian Railways." By Thomas Robertson, C.V.O., Special Commissioner for Indian Railways.

HOT SPRINGS AND THE SIMPLON TUNNEL.

No. VI.*

THE difference between the levels of the drifts in the main tunnel at the north and south sides of the Simplon boring will be about 6ft., if the present gradient of 1 per 1000 at the Italian end is continued up to the ultimate encounter of the headings, and the crown of the latter will thus undermine the floor of the Swiss heading, where there is accumulated about 1800 tons of water, fed continually with hot springs aggregating 1080 gallons per minute in the submerged parts of the headings, or a total of about 1600 gallons per minute, including all infiltrations from the summit of the tunnel line—whereat the 7 per 1000 gradient ends. From this it will be seen that the encounter so effected would be most unfavourable, and—unless the north side could be completely drained—attended with considerable danger, to avoid which several plans are available. One would be to increase provisionally the grade at the Italian end in order to work the heading up to the crown level, and thus meet the Swiss heading of No. 1 tunnel at nearabouts the same level; or, better still, to make the junction with the secondary tunnel, No. 2, by advancing this latter to very near the advance heading of the Swiss tunnel No. 2, and then, by means of a forwardly-advancing cross passage, to cut into the main heading, No. 1, at a height just above the crown of this last, and not far from the water gates, in such manner that the pressure of the water encountered would be reduced to that due to the flow of the hot springs alone, and without the static pressure of the large body of water accumulated in the headings. Moreover, a third gallery branching northwards from the cross-passage just indicated could be driven on until the submerged headings were outdistanced, and the junction so effected in comparatively dry tunnel. Plans for a middle or third gallery, driven at a low level between the two existing tunnels, and destined exclusively for their drainage, towards Iselle, have already been suggested with variations of detail; and such a passage might possibly be applied here for tapping the inundated portions of the Swiss headings. But there are certain objections to the adoption of a smaller section of advance drift than of those already employed, the principal of which is that this auxiliary heading must almost inevitably pass through the same water-bearing fissures, and, in the case of an encounter with a large inburst of hot water, this would very possibly suffice to end all further advance through such a narrow passage, although in an emergency, or for a short distance, the avoiding drifts might be employed with success at certain critical stages of the final operations.

In supposing, however, that a direct junction with the Swiss headings is unavoidable, it is considered that the difficulty may be surmounted if in the last blasting work a hole of considerable aperture can be blown out of the diaphragm of rock intervening between the north and south headings, and of such dimensions that the liberated water would pass freely and rapidly through into the Italian workings, to the speedy reduction of its pressure. But if, on the contrary, the last detonation merely opens the seams or effects only a small opening, the velocity and violence in the flow of the water bursting through the heading face may be such as to render extremely difficult, and even dangerous, the hand work which will then be necessary to continue the operations of advance. Even in the enlargement of spring orifices occurring in the sides of the tunnel, the excavation is not unaccompanied with risk, large fragments of loosened rock often being projected some distance in the spurting water, and sometimes inflicting bodily injuries. The possibilities are that the difficulties will be of a serious nature unless, by some fortuitous circumstance, an alteration in the flow of the springs should occur.

As may be readily supposed, the whole force of the great plant at the Swiss side will be concentrated, some days previous to the encounter, upon the drainage of the headings, in order to maintain the depth of water due to the infiltrations at its lowest. These operations will be carried out under different circumstances from those existing last May, when the rock borers were at work, and when so much of the available power had to be employed for the refrigeration of the tunnel. The whole duty of the Swiss plant, utilising every unit of power available at Brig, will be to drain the tunnels, and, when a breach is made between the headings, to drive in all the cooling water possible for the assistance of the Italian side. The complete stoppage of operations throughout the Swiss tunnels will then, for the moment, not have the serious objection that existed earlier in this year. The heaviest pumping work will, of course, be done in the cross passage, No. 52, where the installations will be on a scale never before seen in a heading of such a restricted area at a point so far distant from the source of power. The illustration upon page 245, in our issue of September 9th, is typical of the means adopted in at least one of the great engineering difficulties met with in the boring of the Simplon.

Behind the heavy dams of wood which now bar the tunnel headings, in front of the iron gates—see page 489—there is, first of all, and without passing the gates, in tunnel No. 2, a valve on the 400 mm. hot-water drain service for discharge, without pumping, of such water as can, by the force of the springs and syphonage, be drawn off near the upper part of the heading. On the left-hand side there is a 12in. suction pipe, running back to pumps placed at kilom. 9·859, the water collected at this point being due to surface flows from the summit of the line downwards; and also from the tunnel No. 1 by means of the 10in. drain pipe, the upper orifice of which is to be noted on the left-hand side of the No. 1 gateway. The difference of level between the two extremities of this pipe is 19½in. Besides collecting surface flows, it can also carry off the heavy water discharge from the 300 mm. (12in.) pipe, shown in the right-hand side of the gateway No. 1. A suitable stop valve is fitted on this latter pipe, which is placed at floor level, and could be used to draw off a large volume of water before the gates were opened.

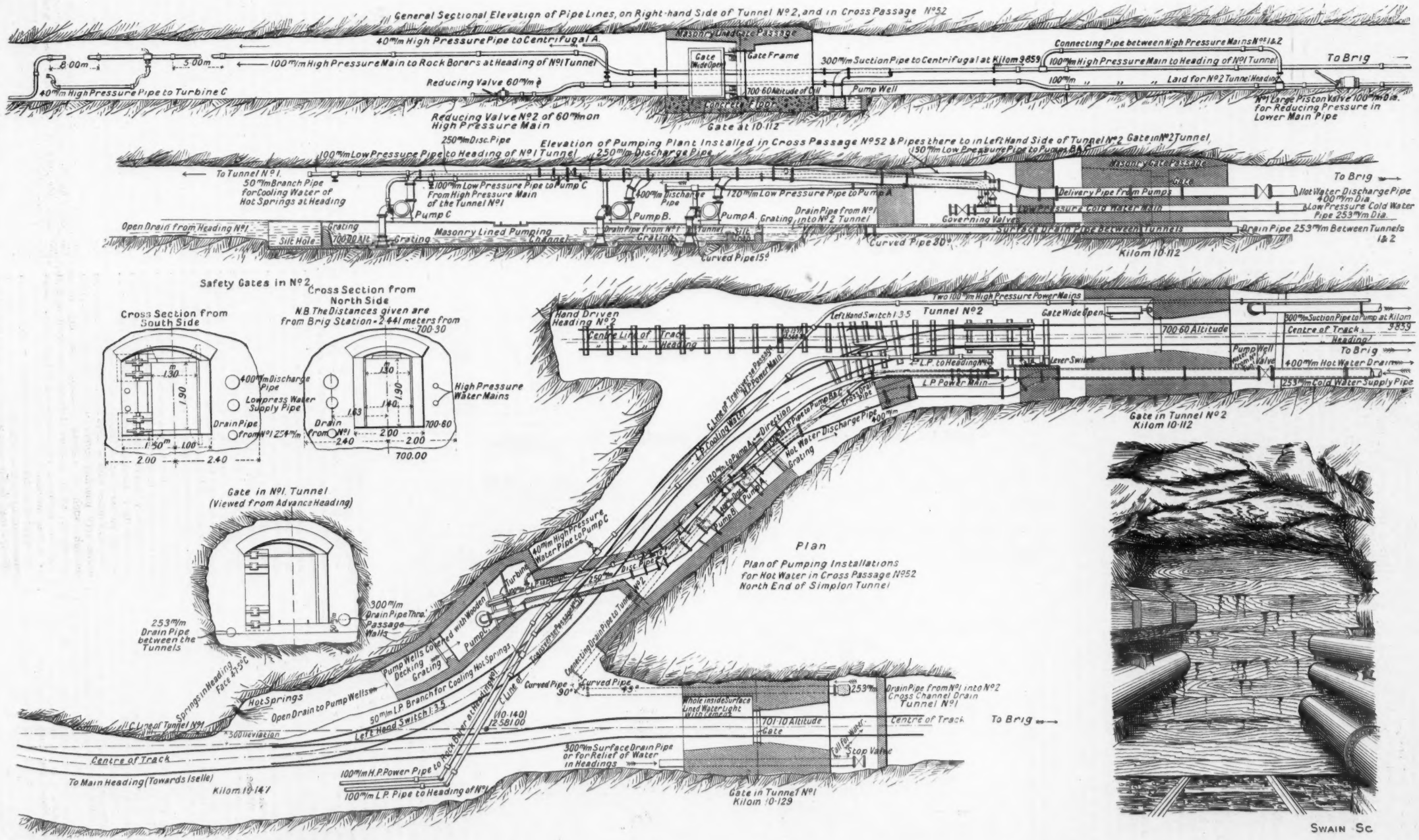
Beyond the gates the whole of the installations which existed while the rock borers were at work is shown, save for the 18in. ventilating pipe which conveyed air to the face of No. 1 advance-heading from a fan stationed back at kilom. 10·104 in tunnel No. 2. Here, in passage No. 52, are the three centrifugal pumps, direct coupled to Pelton turbines, having a total capacity of 5760 gallons per minute at full pressure. Some idea of the movement which took place near these gates may be gathered from the mention that, besides the pumps and numerous ejectors for draining the workings, there were rock borers—at one time operating in near proximity—and construction trains, drawn by compressed-air locomotives, passing regularly through the same narrow transverse passage between the tunnels. Meanwhile the whole section was deluged with springs issuing from all sides and sprayed with large jets of cold water projected from nozzles, the heated water streaming over a floor full of holes, and even submerging the planks laid upon beams in places where dangerous underfoot. The great heat, finally intolerable, spread through a steaming atmosphere impregnated, after each detonation of the heading mines, with sulphurous fumes that escaped slowly and with difficulty through the small gate passage No. 1, while the bursting of some conduit or other accident to pipes or valves, carrying heavy pressure, or the inburst of some fresh hot spring, all taking place in such confined quarters—dimly illuminated by the oil lamps of the miners—required alert engineering skill to direct the work in every emergency, and such as, it may be ventured, is not often called for in similar enterprises.

The plan and the sections make clear every detail of the installations, but to summarise these it may be mentioned that the discharge conduit from the pumps is of 400 mm. diameter, and arranged as detailed upon page 245. The two power mains of 4in. diameter are carried through the right-hand side of No. 2 gate passage, but, as that one for No. 2 heading was not required after last February, when work at that heading was definitely discontinued, it is provided with a lever reducing valve of piston type, and then, in advance of the gates, connected by a loop to the high-pressure main of No. 1 tunnel. On the other side of the gate a smaller valve of similar type is provided at its extremity, and a 40 mm. (1⅝in.) pipe branching from the main reinforces the power supply to the turbine of the first pump A. The power for the turbines is taken by branches from the 253 mm. low-pressure cold-water main, which passes through the left-hand wall of No. 2 gate passage. The branch to turbine A is of 120 mm. diameter, and of 150 mm. (6in.) diameter to turbine B, and 100 mm. diameter in the prolongation therefrom to turbine C. Pressure at this extremity is reinforced by a 40 mm. branch pipe taking water direct from the high-pressure

* No. V. appeared October 28th.

SIMPLON TUNNEL—ARRANGEMENT OF PRESSURE AND DRAIN PIPES

(*For description see page 488*)


General Sectional Elevation of Pipe Lines, on Right-hand Side of Tunnel No 2, and in Cross Passage No 52
Masonry Underdrive Passage
40m/m High Pressure Pipe to Centrifugal A
Gate Wide Open
Gate Frame
300m/m Suction Pipe to Centrifugal at Kilom 9859
Connecting Pipe between High Pressure Mains No 1 & 2
100m/m High Pressure Main to Heading of No 1 Tunnel
To Brig
8.00m
5.00m
100m/m High Pressure Main to Rock Borers at Heading of No 1 Tunnel
40m/m High Pressure Pipe to Turbine C
Reducing Valve 60m/m ø
700.60 Altitude of C/L
Pump Well
100m/m " " Laid for No 2 Tunnel Heading
Concrete Floor
Reducing Valve No 2 of 60m/m on High Pressure Main
Gate at 10-112
No 1 Large Piston Valve 100m/m Dia. for Reducing Pressure in Lower Main Pipe
250m/m Disc. Pipe
Elevation of Pumping Plant Installed in Cross Passage No 52 & Pipes there to in Left Hand Side of Tunnel No 2 Gate in No 2 Tunnel
100m/m Low Pressure Pipe to Heading of No 1 Tunnel
250m/m Discharge Pipe
150m/m Low Pressure Pipe to Pump BA
Masonry Lined Passage
To Tunnel No 1.
50m/m Branch Pipe for Cooling Water of Hot Springs at Heading
100m/m Low Pressure Pipe to Pump C From High Pressure Main of the Tunnel No 1
400m/m Discharge Pipe
120m/m Low Pressure Pipe to Pump A
Delivery Pipe from Pumps
To Brig
Hot Water Discharge Pipe 400m/m Dia.
Low Pressure Cold Water Pipe 253m/m Dia.
Pump C
Pump B.
Pump A.
Drain Pipe from No 1 into No 2 Tunnel
Governing Valves
Open Drain from Heading No 1
Silt Hole
Grating
700.00 Alt.
Masonry Lined Pumping Chamber
Drain Pipe from No 1 Grating
Tunnel
Silt Hole
Curved Pipe 15°
Curved Pipe 30°
Kilom 10-112
Drain Pipe 253m/m Between Tunnels 1 & 2
Safety Gates in No 2
Cross Section from South Side
Cross Section from North Side
NB The Distances given are from Brig Station = 2441 meters from
700.30
400m/m Discharge Pipe
Low press Water Supply Pipe
Drain Pipe from No 1 253m/m
High Pressure Water Mains
Drain from No 1
700.60
Gate in No 1. Tunnel (Viewed from Advance Heading)
253m/m Drain Pipe between the Tunnels
300m/m Drain Pipe Thro' Passage Walls
Springs in Heading Face 41.5°C
Hot Springs
Pump Wells Covered with Wooden Decking
Grating
Pump C
Open Drain to Pump Wells
50m/m L.P Branch for Cooling Hot Springs
Left Head Switch 1:35
C/Line of Tunnel No 1
300 Deviation
Centre of Track
To Main Heading (Towards Iselle)
Kilom 10-147
100m/m H.P Power Pipe to Rock Borer at Heading No 1
100m/m L.P. Pipe to Heading of No 1
Hand Driven Heading No 2
Centre Line of Tracks Heading
Two 100m/m High Pressure Power Mains
Left Hand Switch 1:35
Tunnel No 2
Gate Wide Open
700.60 Altitude
300m/m Suction Pipe to Pump at Kilom 9859
Centre of Tracks Heading
To Brig
Pump Well
Lever Switch
400m/m Hot Water Drain
253m/m Cold Water Supply Pipe
L.P to Heading No 2
L.P Power Main
C/Line of Transverse Passage
H.P Power Main
H.P Cooling Water
Pump A—Direction
L.P Pipe to Pump A & C
Cross Drain Pipe
400m/m
Hot Water Discharge Pipe
Grating
120m/m to Pump A
Pump B
Pump A
Gate in Tunnel No 2 Kilom 10-112
Plan
Plan of Pumping Installations for Hot Water in Cross Passage No 52 North End of Simplon Tunnel
40m/m High Pressure Water Pipe to Pump C
Turbine
Disc Pipe to Pump
Connecting Drain Pipe to Tunnel
Transverse Passage
C/Line of
Curved Pipe 30°
Curved Pipe 15°
Whole inside Surface Lined Water Light with Cement
253m/m
Drain Pipe from No 1 into No 2 Cross Channel Drain Tunnel No 1
701.10 Altitude Gate
Centre of Track
To Brig
Cast Iron Weight
Stop Valve
300m/m Surface Drain Pipe or for Relief of Water in Headings
(10-140) 12.581.00
Gate in Tunnel No 1 Kilom 10-129

SWAIN Sc

main of the rock borers. A third branch pipe, of 100 mm. diameter throughout, continues the cooling water service onwards from the gate to No. 1 heading, running parallel with the high-pressure main. All the pump-wells in the transverse passage are completely covered with a removable decking.

In the plan it will be noticed that at kilom. 10.147 it was found preferable to deviate the heading there than to attempt to cut through a hot spring occuring in the face of the heading.

DESIGN OF HIGH-SPEED ENCLOSED STEAM ENGINES.

No. III.*

The type of crosshead now most generally used is that illustrated in Fig. 14. The crosshead is forged with the piston-rod, which is good practice, as a cottered or screwed joint is dispensed with, and height is saved. The steps should be of good quality gun-metal or phosphor bronze, as white metal is inadmissible. White metal is occasionally used for lining crosshead slippers. This is not at all necessary, but they must be of ample area.

The illustration shows the method of conducting the oil under pressure from the crank pin up to the crosshead pin, and then to the slides. Some makers prefer to carry a separate pipe to the slides, and lubricate the crosshead pin from this source. The crosshead slipper must then be of such a length as not to uncover the hole in the slide, or must be slightly longer than the stroke of the engine.

The one-bearing crosshead, with a pin forced into the jaw of the connecting-rod, has practically become universal,

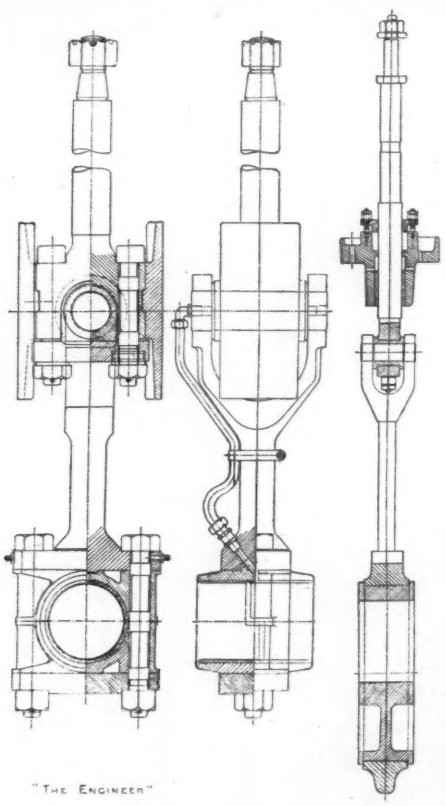


Fig. 14 Fig 15

and has much in its favour. Two bearings require careful adjustment, and even then, if not of similar metal, do not receive equal loads, and are not to be recommended.

Piston-rod and connecting-rods are of necessity very short, and consequently stiff, but should not be cut down too much on this account. A point often forgotten in engine design is that it is not always the strength alone which can limit the size of the parts, but the stiffness necessary for satisfactory working.

The connecting-rod illustrated in Fig. 14 shows a good type very generally used, with a palm end formed on the rod for attachment to brasses, and a steel cap under the bottom brasses. Some manufacturers prefer the solid-type end with round bushes. This is very neat in appearance; the brass steps are quite cheap to manufacture and stock, or replace. Of course, the principle of the end remains the same, a cap with two bolts being the only means of adjustment.

The valve motion of high-speed engines has been through many stages of development, and has finally levelled itself to the old excentric and rod, driving the valve direct. Link motions appear to have had their day and disappeared.

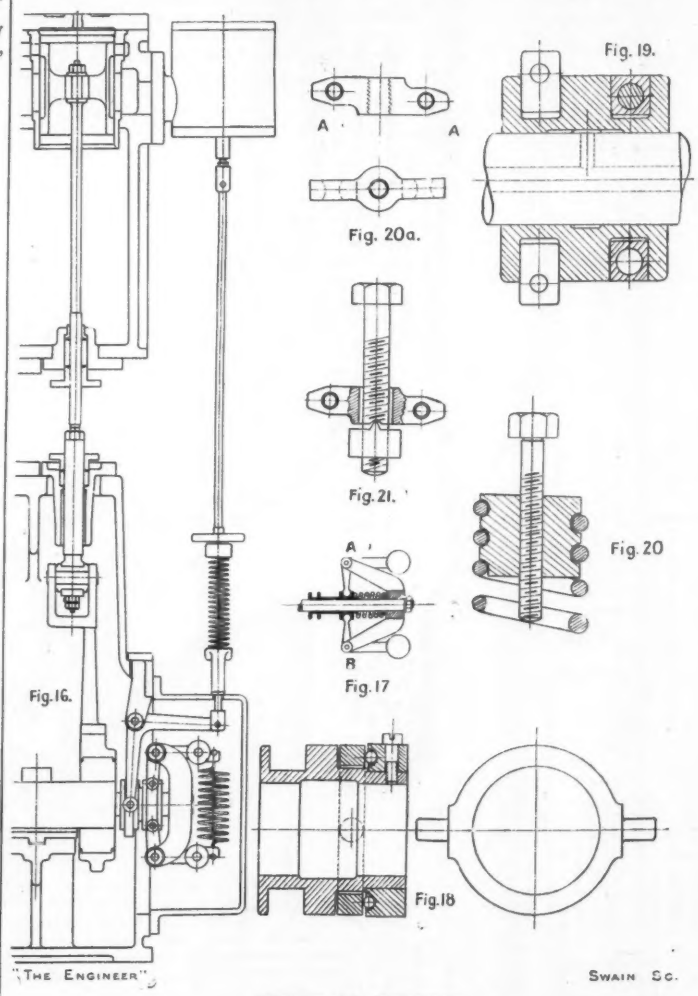
In designing this portion of the engine ample sizes should be allowed to give stiffness, and ample surfaces should be given to all bearings, good wide excentrics and large valve spindle pins being absolutely necessary for quiet running. Although the valve is of the solid piston type, and is practically frictionless, its inertia effect is something considerable, and on this account the weight of the valve gear must be carefully considered with regard to its effect upon the balance and vibration of the engine, as in large sets this is liable to have a very nasty disturbing effect, and cause serious trouble.

A good plain substantial type of valve motion for an engine of medium size is shown in Fig. 15. The valve spindle crosshead, as shown, is on the same principle as the main crossheads of the engine just described, and makes a simple and yet efficient design. The guide is only a plain cast iron bracket put in from the top of the frame and bushed with gun-metal. The whole of the motion is placed under forced lubrication, the drawing fully explaining this. The valve spindle guide is provided with a wiper gland the same as the piston-rods in this case, to prevent the oil passing up to the top of the frame, and at the same time to prevent the drip from the glands passing down to the crank chamber.

The spindles should be made to tighten on to the valve boss, and all the floating be done by the body of the valve in its rings. Any adjustment necessary for valve setting can be made in the bottom washer under the boss of the valve. As in all other moving parts of the engine, all nuts should be locked. Most manufacturers now line the excentric clips with white metal, which is good practice, owing to the high surface speed, and the clips run much sweeter and cooler, generally speaking, than when made of cast iron.

The governing of high-speed engines has been much written about, and has undoubtedly been a problem with which all the leading firms have been experimenting with for many years.

Many types of governors have been tried, both for variable expansion and throttle governing, and more particularly the former, some firms having spent many thousands of pounds in bringing to perfection a governor



DETAILS OF GOVERNOR

to control the engine by altering the cut-off, but very few have been successful.

As this portion of the engine is one which has had to receive special consideration to make it suitable for high speed, it will be dealt with somewhat in detail here. Owing to the high rotative speed, no gearing is required for the governor, and it can be placed direct on the engine crank shaft, and so saves any intermediate gearing. This simplifies the governor, but, on the other hand, it is a far more difficult matter to alter the cut-off on an engine with valves driven by a positive gear than one driven through a trip gear. Very powerful governors are required to actuate the valve gear, and at the same time be able to alter the position of the same to control the speed. On this account, very few firms manufacture high-speed engines with governors of the variable-expansion type, and although it is a well-known fact that it is more economical to use variable expansion with a varying load down to a very low load, engineers prefer an engine governed by a throttle governor, slightly inferior in economy, to one which is liable to give trouble.

The high-speed engine lends itself very well to throttle governing; the governor can be placed on the crank shaft and connected to the throttle valve in a very direct manner, and it is a comparatively easy matter to design a powerful governor to control a throttle valve. This type of governor also lends itself very well for alteration of the speed while the engine is running, which is a great convenience in electrical stations.

Most throttle governors are of the plain centrifugal two-weight type, the position of the weights being controlled by springs in tension. This is really the universal type, the only variation being in the actual design of the parts and the shape of the weights, &c. In designing the governor, it is always advisable to err on the big side rather than the small, as then any slight defect in the valve will not upset the governing a measurable amount.

Fig. 16 represents a good design of high-speed throttle governor, which has given every satisfaction in working. This governor is suitable for controlling an engine with a throttle valve of balanced type, from 3in. to 3½in. in diameter, when running at from, say, 300 to 500 revolutions per minute.

It is very important that the stresses in the governor itself, or the centrifugal force of the weights, are not transmitted through the joints, and so increase the friction in the governor due to its own internal stresses. This is avoided in the design under consideration by placing the springs between the centre of gravity of the weights, and so taking the centrifugal force direct. The only force transmitted through the governor levers is that necessary to overcome a change in the position of the throttle valve and the amount necessary for speeder gear when fitted. If the governor is arranged as shown in diagram Fig. 17, it will be seen that all the stress has to pass through the joints A B, and this, although neat, is not advisable, as the wear in the governor pins is increased, and the friction is liable to make the governor sluggish.

The governor weights are of cast steel, and are carried by the bracket keyed to the shaft as shown, this bracket being provided with pins for that purpose. The weight levers are coupled to the sleeve sliding on the crank shaft through a pin and block, as shown. This, although not perhaps as cheap as a tongue piece engaging with the sleeve, as is very commonly done, is a far more satisfactory arrangement, and will wear for years, whereas the tongue referred to often grooves the sleeve, and interferes with the free action of the governor. When a pin and block is fitted as shown no such grooving can take place, and ample surface can be arranged for. Another method of coupling the weights to the sleeve is by means of a roller on the pin in place of the block. This is very good while new, but the small motion is not suitable for a rolling joint, and the roller wears locally only. The sleeve may be coupled to the valve lever in many ways, but if the sleeve is built up, care must be taken to get it absolutely true. Several firms have made sleeves as shown in Fig. 18, but this is an unnecessary refinement, considering the load to be dealt with and the efficient supply of lubrication handy. Fig. 19 illustrates a very substantial and good design of sleeve, and as it is generally convenient to place all working surfaces under forced lubrication, it is nearly ideal, as it can be made in one piece, and is cheap to machine. The trunnion requires to be split, but this is easily overcome, as shown, and is preferable to a built-up sleeve.

The springs are often very troublesome details in connection with governors, as speeds, pressures, and loads are rarely constant for engines of the same size. A great deal in the way of adjustment can be done by altering the weights, if these are arranged to facilitate this; but it is also a great convenience to be able to alter the tension of the spring, as well as the stiffness, or load, per inch extension. In very small engines this may not be necessary, as a sufficient variety of springs can be stocked, but in engines of large size an adjustment at this point is advisable. This can be effected in several ways. A method adopted by several firms is to fit a nut into the coils of the springs as shown in Fig. 20. This nut has a thread cast on, of similar form and pitch to suit the spring, and is tapped to suit the adjusting screw as shown. By this screw the tension can be altered to suit speed, &c. If it is required to alter the variation throughout the range, this can be done by screwing the nut farther into the spring, and so using less coils. The governor can thus be adjusted through a very large range, as, say, two or twenty coils may be used, as it matters little whether two or twenty coils are used so long as the maximum total load the spring is suitable for is not exceeded.

Another method for achieving the same object is shown in Fig. 20*a*. This is a cheaper and even better method, as it is easy to arrange the holes to suit the pitch of the spring; in fact, if made as shown in Fig. 21, the shackle adjusts itself to suit the altered pitch due to extension of the spring.

To alter the pounds per inch extension the shackle is simply wound round the coils to the required place.

* No. II. appeared November 4th.

These shackles are largely used in America in connection with variable expansion shaft governors. As these springs are of considerable size, the shackles are generally provided with ears at A A to enable them to be easily hammered round the coils when required for adjustment. This can be done with the spring in place on the governor without even slacking back the spring.

The throttle governor is usually fitted at the high-pressure end of the crank shaft, and the throttle valve placed almost immediately over it. The valve can then be actuated through a bell crank lever and rod in a very simple manner, with a minimum number of joints. This arrangement also lends itself very well for speeding the engine, as the speeder spring can very neatly be attached to the vertical rod, as shown in Fig. 16. The lower part of the spring should be fixed to the engine frame or governor casing.

The speeder and governor illustrated are suitable for an engine of about 150 indicated horse-power, with throttle valve 3in. diameter, and running at 450 to 500 revolutions per minute.

The following is a table giving the sizes of coiled steel springs, of all dimensions generally required for governors, and which will be found very useful for reference when designing governors:—

SPRINGS.—Table giving working load and deflection of spiral springs of round steel. D = outside diameter of coil; d = steel diameter; W = safe working load, tensile strain not exceeding 60,000 lb. per square inch; F = deflection of one coil with 100 lb. load, and a modulus of elasticity of 12 millions.

d																	
·065	D	·25	·5	·75	1·0	1·25	1·5	1·75	2·0								
	W	25	15	9	7	5	4·5	3·8	3·3								
	F	·0236	·3075	1·228	3·053	6·214	11·04	17·87	27·06								
·12	D	·5	·75	1·0	1·25	1·5	1·75	2·0	2·25	2·5							
	W	107	65	46	36	29	25	22	19	17							
	F	·0176	·0804	·2191	·4639	·8448	1·392	2·136	3·107	4·334							
·18	D	·75	1·0	1·25	1·5	1·75	2·0	2·25	2·5	2·75	3·0						
	W	241	167	128	104	88	75	66	59	53	49						
	F	·0118	·0350	·0778	·1460	·2457	·3828	·5632	·7928	1·077	1·423						
·25	D	1·25	1·5	1·75	2·0	2·25	2·5	2·75	3·0	3·25	3·5						
	W	368	294	245	210	184	164	147	134	123	113						
	F	·0171	·0333	·0576	·0914	·1365	·1944	·2665	·3548	·4607	·5859						
·3125	D	1·5	1·75	2·0	2·25	2·5	2·75	3·0	3·25	3·5	3·75	4·0					
	W	605	500	426	371	329	295	267	245	226	209	195					
	F	·0117	·0207	·0336	·0508	·0732	·1012	·1357	·1771	·2263	·2839	·3505					
·375	D	2·0	2·25	2·5	2·75	3·0	3·25	3·5	3·75	4	4·25	4·5					
	W	765	663	589	523	473	433	398	368	343	321	301					
	F	·0145	·0222	·0323	·0452	·0610	·0801	·1029	·1297	·1606	·1993	·2367					
⅝	D	2·0	2·25	2·5	2·75	3·0	3·25	3·5	3·75	4·0	4·25	4·5	4·75	5·0			
	W	1263	1089	957	853	770	702	644	596	544	518	486	458	432			
	F	·0069	·0108	·0160	·0225	·0306	·0405	·0529	·0661	·0823	·1008	·1228	·1459	·1728			
½	D	2·0	2·25	2·5	2·75	3·0	3·25	3·5	3·75	4·0	4·25	4·5	4·75	5·0	5·25	5·5	
	W	1963	1683	1472	1309	1178	1071	982	906	841	785	736	693	654	602	589	
	F	·0036	·0057	·0085	·0121	·0167	·0222	·0288	·0366	·0457	·0562	·0683	·0818	·0972	·1143	·1333	
⅜	D	2·5	2·75	3·0	3·25	3·5	3·75	4·0	4·25	4·5	4·75	5·0	5·25	5·5	5·75	6·0	
	W	2163	1916	1720	1560	1427	1315	1220	1137	1065	1001	945	894	849	808	771	
	F	·0048	·0070	·0096	·0129	·0169	·0216	·0271	·0334	·0406	·0489	·0582	·0686	·0801	·0930	·1071	
⅝	D	2·5	2·75	3·0	3·25	3·5	3·75	4·0	4·25	4·5	4·75	5·0	5·25	5·5	5·75	6·0	
	W	3068	2707	2422	2191	2001	1841	1704	1587	1484	1394	1315	1244	1180	1122	1070	
	F	·0029	·0042	·0058	·0079	·0104	·0133	·0168	·0208	·0254	·0307	·0366	·0432	·0506	·0588	·0679	
¾	D	3·0	3·25	3·5	3·75	4·0	4·25	4·5	4·75	5·0	5·25	5·5	5·75	6·0			
	W	3311	2988	2723	2500	2311	2154	2009	1885	1776	1678	1591	1513	1441			
	F	·0037	·0050	·0066	·0086	·0108	·0135	·0165	·0200	·0239	·0283	·0333	·0387	·0447			
⅞	D	3·0	3·25	3·5	3·75	4·0	4·25	4·5	4·75	5·0	5·25	5·5	5·75	6·0			
	W	4418	3976	3315	3313	3058	2840	2651	2485	2339	2209	2093	1988	1893			
	F	·0024	·0033	·0044	·0057	·0072	·0090	·0111	·0135	·0162	·0192	·0226	·0263	·0305			
1	D	3·5	3·75	4·0	4·25	4·5	4·75	5·0	5·25	5·5	5·75	6·0	6·25	6·5			
	W	6913	5490	5051	4676	4354	4073	3826	3607	3413	3237	3080	2936	2806			
	F	·0018	·0021	·0030	·0038	·0047	·0058	·0070	·0083	·0098	·0115	·0134	·0155	·0177			
1	D	3·5	3·75	4·0	4·25	4·5	4·75	5·0	5·25	5·5	5·75	6·0	6·25	6·5	6·75	7·0	
	W	9425	8568	7854	7250	6732	6283	5890	5544	5236	4960	4712	4488	4284	4098	3927	
	F	·0010	·0014	·0018	·0023	·0028	·0035	·0043	·0051	·0061	·0071	·0083	·0096	·0111	·0127	·0144	

A powerful inertia type of throttle governor was illustrated in THE ENGINEER of May 27th, 1904. This type of governor is used by Messrs. Browett, Lindley and Co., Limited, Patricroft.

There are many designs of this class of governor made, but they simply vary in little details, and that shown in Fig. 16 may be taken as representing the general type. The throttle valve plays a most important part in the question under consideration, as no matter how good and powerful the governor may be, if the throttle valve leaks, or is liable to stick, the governing is bound to be unsatisfactory. In designing a throttle valve there are several points to watch. One condition is essential, and that is, that it must be tight when closed, and it should be easy to close without any great force, as the only force available to move the valve is that due to the governor. If a valve is difficult to move, a powerful governor will be required to move it, so one of the first considerations is to get a valve of a balance type easy to move. The valve must also be tight, and not affected by steam pressure or temperature.

The throttle valve of the early days was simply a twisting plate in a pipe, or what is generally known as a "butterfly"; this answered the purpose when pressures were low, but is useless in these days of high pressures and superheat.

The simplest type of valve to fulfil the conditions given, for a time at any rate, is one of the piston type. This valve, being in balance, is easy to move, can be made tight at first, and, if carefully designed, can be made of such a form as not to be affected by high temperature.

AN IMPORTANT AMALGAMATION.—We understand that Dick, Kerr and Co., Limited, Callenders Cable and Electrical Construction Co., Limited, Babcock and Wilcox, Limited, Gwynnes, Limited, and Messrs. Gibb and Co. have joined in the formation of a company, to be termed the British Engineering Company of Egypt, Limited. The object had in view is, of course, the development of trade in a country rapidly growing in commercial importance. The precise functions of the new company will be, no doubt, to act as an agent for the companies included in the amalgamation.

MARINE ENGINE MODELS AT SOUTH KENSINGTON.

SOME extremely interesting specimens of that ever-fascinating subject of study, the marine engine, are now on view in the Science Division of the South Kensington Museum. They form part of the large collection of models contributed to the Museum by Messrs. Maudslay, Sons and Field, on closing their Lambeth Works in 1900. A small portion of this collection was on view when the last catalogue was issued, in 1901, but did not comprise the marine engines, for which, of course, the firm was especially celebrated.

The first example is No. 2217, representing the engines of H.M.S. Devastation, a wooden paddle frigate, built at Chatham 1840-4. She was 220ft. long, 40ft. wide, 26ft. deep, and of 1058 tons measurement. In her were fitted a pair of twin-cylinder "Siamese" engines, of the type patented by Joseph Maudslay and Joshua Field in 1839, the object being to get long-stroke cylinders under the crank axle. There are four vertical cylinders, 54 × 72, in pairs, working two cranks, the crosshead for each set being between the cylinders, and there continued by guides, the connecting-rod extending from the lower end, between two plates forming the crosshead, to its crank pin. There is only a single steam chest, with a long piston slide valve, for each pair of cylinders, the valves each actuated by a rocking shaft by means of loose excentrics. Rack and pinion gears are added for moving the valves by hand, when the gabs were disconnected for reversing. Each pair of cylinders had its own jet condenser, which formed also the base-plate, and by side levers drove its air and feed pumps, all arranged vertically. The model shows the frame of the ship, paddle-boxes, &c. In ten years the makers supplied fifty-five sets of these engines, totalling 48,000 horse-power, one of the vessels being the Royal yacht Victoria and Albert, in 1842, of 1550 horse-power.

The next example, No. 2218, shows the "annular" type of engine fitted in the iron paddle steamer Princess Alice, built in 1843 for the Admiralty's Dover and Calais mail service. She was of only 270 tons, 359 horse-power, and could do 12½ knots with a pair of 18ft. feathering paddles, at a steam pressure of 16 lb. The annular cylinder was designed by Maudslay in 1841, and is a development of the "twin" arrangement; but although more compact, it was less easy to construct, and was not so extensively adopted. In this instance the cylinders are 43 × 42, but through the centre of each was a hollow column, so that the piston surrounded it, and had two rods. These were secured to a double plate crosshead of T shape, the tail of which worked inside the central column, and at the lower extremity received the small end of the connecting-rod, the big end being attached to the crank above. The upper end of the crosshead was also guided; the valve gear and pumps are arranged as in the twin-cylinder engine.

Next comes a modification of No. 2217 to suit screw machinery. As the model shows only one crank it is considered that the great fore and aft length of the arrangement led to its abandonment. There are two vertical cylinders over the crank shaft, with the piston-rods connected by a crosshead moving in overhead guides, from which a connecting-rod passes downwards between the cylinders to the crank. A steam chest common to both cylinders contains a long piston valve driven through a rocking shaft by a single excentric on the crank shaft. Jet condensers are fitted in the bed-plate, air, feed, and bilge pumps being worked from overhead by rocking levers.

No. 2220 is a "double piston-rod steeple engine," a kind patented by Maudslay and Field in 1839, who supplied them for steamers on the Rhône in 1840, and for some of the East India Company's shallow-draught river boats ten years later. It is a vertical form of a construction subsequently extensively adopted in the Navy, and known as the "horizontal return connecting-rod engine." Here the cylinders are placed vertically some distance below the crank shaft, and through the upper covers pass two rods, one on each side of the crank shaft, united above by a crosshead, which slides in vertical guides. From this the connecting-rod descends to the crank shaft; vertical air, feed, and bilge pumps being driven by beams worked by links from the main crosshead. Steam was distributed by a short D slide valve, which in the model is driven by link motion, the link is shifted by hand-wheel and pinion gearing into teeth cut in the link. The short travel of the link would not seriously interfere with the movements of the attendant in reversing or "linking up." The whole arrangement makes a very tall engine. The cranks pass as close to the top cylinder cover as they possibly can; the air cylinder stands away separately altogether. One side of the ship, with the deck and bottom, is shown.

The next four examples, Nos. 2221 to 2224, are all in one case. First come the horizontal direct-action engines of H.M.S. Ajax. She was originally a 74-gun sailing ship, 176ft. long by 48½ft. beam, mean draught 22ft. 1in., tonnage 1761. In 1848 she was turned into a steam block ship of 60 guns without being much altered in dimensions. Her engines, by Maudslay's, were the first screw engines of this type in our Navy. They comprised two cylinders, 55 × 30, on the same side of the crank shaft, the guides being utilised to tie the cylinders to the crank bearings; the connecting rods were four times the crank radius in length. They look very short, and the bearings very large. To shorten the steam passages and reduce the size of the slide valves, there were two to each cylinder, inclined towards each other in a single steam chest, each pair being driven through a single rocking shaft by a link motion. Jet condensers, not shown, were in the bed-plate, and two vertical air pumps were each worked by a pair of excentrics on the crank shaft. Steam at 6 lb. with 48 revolutions gave a speed of only 7·1 knots, the screw being 16ft. in diameter, 17·9ft. pitch, with a slip of 15·7 per cent., 846 horse-power beirg indicated.

Model No. 2222 shows the diagonal direct-action engines of H.M.S. Harbinger, an iron screw steamer, built by Messrs. Mare and Co., of Blackwall, in 1851, for the East India and Cape mail service. She was 186½ft. long, 31ft. broad, 19·2ft. deep, with a gross tonnage of 848. Maudslay's engines had cylinders 41½ × 27, working upwards to a single crank. Two slide valves for each cylinder were worked by rocking shafts driven by excentrics. The condenser was under the crank shaft, formed in the engine framing or bed. A vertical air pump was driven by an outside crank, which also drove the feed and bilge pumps, but had a shorter stroke than the main or driving crank. Steam at 15 lb. from tubular boilers, 26½ revolutions per minute, was the working system, 16 tons of coal being burned every twenty-four hours. It should be added that one of the connecting-rods is, necessarily, double, the other working within it, and that the slide valves are arranged as in the Ajax.

In No. 2223 we have an example of engines used as auxiliary power in one of the grandest of the old "wooden walls." This was H.M.S. Marlborough, begun at Portsmouth in 1850 as a sailing ship of 131 guns, but when launched in 1855 she had been fitted with a screw. She was 245½ft. long, 61·2ft. beam, 25·8ft. deep and had a displacement of 6050 tons. On trial her draught was 26·3ft., the immersed midship section being 1190 square feet. The engines are of Maudslay's return connecting-rod type, with a pair of cylinders 82 × 48, with two valve chests to each and link motion reversing gear worked by a screw hand wheel. The propeller was 19ft. in diameter, 3½ft. long, about 26ft. pitch, and had a slip of nearly 22 per cent. With 20 lb. steam and 56 revolutions, 3054 horse-power was indicated and a

speed of 11·2 knots. In another part of the Museum is a large sectional drawing of this vessel, showing the arrangement both of the armament and the machinery.

Next to it are the engines of the despatch boat Wanderer, designed by the Admiralty, and built by Wigram and Green in only nine months during the Crimean war. She was 180ft. long, 28·3ft. beam, with a mean draught of 10½ft., and a displacement of 745 tons. Horizontal engines, by Maudslay's, of the return connecting-rod type, had two cylinders 45 × 24. Condensers of jet pattern are fixed centrally opposite the cylinders, there are two horizontal air pumps driven by an additional rod from each piston, while the other pumps are worked directly from the crossheads. The link-motion is counterbalanced, and reversed by rack and pinion gear. On trial, with 20 lb. steam and 83¼ revolutions, 706·8 horse-power was indicated, but the speed was only 10·7 knots. The screw was 11ft. in diameter; 16ft. pitch, 2½ft. long, the slip being 18·3 per cent. These engines are very compact, but somewhat peculiar. The rod connecting the reversing gears passes across the top of the cylinders very close to them, the steam pipe being at the back. The air pump is between the slide bars above the bed-plate.

In No. 2225 we have a return to the annular type shown in No. 2218, but now arranged for screw engines. Vertical cylinders are placed over the crank shaft, each with its connecting-rod passing from a guided crosshead on the top of the cylinder through the central passage to its crank. Air pump crossheads, which serve also for feed and bilge pumps, are worked by levers directly attached to the connecting-rods, and accordingly carried on swinging fulcrums; these pumps are all arranged above the jet condensers, which are at the sides. The whole apparatus is very compact and neat. The model is from the steam yacht Hebe, but similar engines were fitted in H.M.S. Pelter and Despatch, of 220 horse-power, in 1866-8.

No. 2226 brings us back to the paddle steamer, in the shape of the well-known oscillating engine of the type patented by Joseph Maudslay in 1827. The example is from the steamer Mersey, built of iron at Millwall by Samuda Brothers in 1859 for the West Indian mail service. She was 260·4ft. long, 30·2ft. beam, 16·2ft. deep, had a mean draught of 18·5ft., and a gross tonnage of 1001. The cylinders are 60 × 60. The general arrangements of this class of engine are too well known to require description. Suffice it to say that the upper framing is tied to the engine bed by eight inclined wrought iron columns, which with the six excentric rods of the valve gear and air pumps give a singular appearance to the whole. The vessel carried twelve days' supply of coal, and with 20 lb. steam and 30 revolutions the engines drove her at 11½ knots. One paddle-wheel is shown with fixed, the other with feathering, floats; the frames of the ship are also shown. Models 2227 and 2229 do not seem to be shown, but No. 2228 brings us to the three-cylinder epoch with the engines of H.M.S. Octavia. She was originally a 51-gun sailing frigate, of wood, but was altered in 1860 to a screw frigate of 3161 tons, carrying 35 guns. The cylinders are in a row, all 66 × 42, the cranks being at 120 deg. to secure good balancing. Steam jacketing is employed. Each cylinder has two double-ported slide valves driven by the gear patented by Charles Sells in 1859. In this the valves are all worked from a shaft, each by an excentric set at a suitable angle of advance for the corresponding crank, the shaft being driven by four spur wheels carried in an adjustable frame, by moving which the shaft underwent a relative angular movement which reversed the engines, or would alter the point of cut-off from ·25 to ·16 of the stroke. The two condensers are opposite the cylinders, the pumps are driven by additional rods from the outermost cylinders. Steam at 20 lb., with 69½ revolutions per minute, gave a speed of 12½ knots and 2265 horse-power, on the ship's trials in 1861.

Both these and the engines of H.M.S. Agincourt, No. 2230, are of the return connecting-rod pattern. In the latter we come to the rotary expansion valves introduced by Joshua Field, driven by spur gearing from the crank shaft. The vessel was one of the earliest ironclads, built by Laird at Birkenhead in 1862. With two cylinders, 91 × 54, she did 12 knots, 4000 horse-power being indicated. The series concludes with model No. 2231, which shows the inverted tandem compound engines of the White Star Britannic, built at Belfast by Harland and Woolf in 1874. With a boiler pressure of 70 lb., 13 knots was made on her first voyage out, the high-pressure cylinders, 48 × 60, being on the top of low-pressure, 83 × 60. The scale of these beautiful models varies from ⅛ to $\frac{1}{12}$, but is mostly $\frac{1}{12}$. They are kept in slow motion by belts driven from shafting turned by compressed air.

LIVERPOOL DOCKS IMPROVEMENTS.

In our issue of the 28th ult. we give an illustration and description of the Vulcan, a powerful and deep-working bow-well bucket ladder dredger just added to the dredging plant of the Mersey Docks and Harbour Board. In view of the increased dredging facilities recently provided, it may be of interest to give a few general particulars of the improvements made and still vigorously being made on the Liverpool estate of the Mersey Docks and Harbour Board. These improvements consist of instalments of two large schemes initiated with the object of making and maintaining the port of Liverpool fully capable of dealing conveniently with steamers of the very largest class. The first of these schemes, authorised by Parliament in 1891, with subsequent additional powers, comprised alterations of the docks at the north end of the estate, those chiefly affected being the Canada and Huskisson docks.

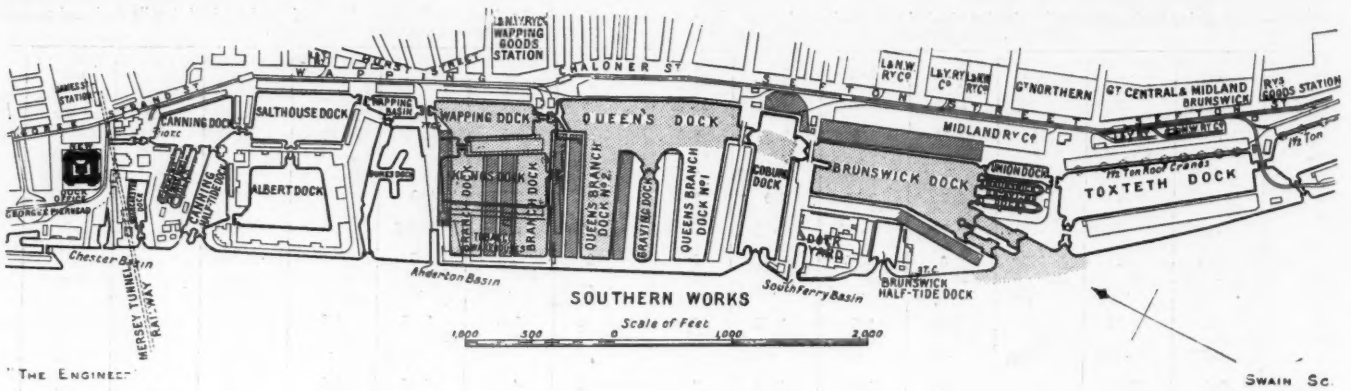
Previous to the beginning of this year the Sandon Half-tide Dock—the key of the new system—having two deep-water entrances, 100ft. and 80ft. wide respectively, from the river, had been completed and brought into use, and a large extent of quayage in the Canada and Huskisson docks had been altered so as to afford much greater depth than formerly. Many of the quays also had been provided with new wide sheds, some of one-storey and others of the two-storey type. The entirely new docks, viz.:—Canada Branch Docks Nos. 1 and 2, and Huskisson Branch Dock No. 1, with the like first-class shed accommodation, have been brought into use. At present this northern system is being farther extended by the construction of the Canada Branch Dock No. 3, and the alteration of the old Sandon Dock by making an increase of about 13ft. to its depth and the addition of five double-storey sheds on the north and east quays. Adjoining this system of docks, the Brocklebank Dock, which, as will be seen from the plans herewith, lies between the Canada and Langton docks, is being deepened, the passage between it and the Canada Dock is also being deepened, and a new wider and deeper passage is being constructed between the Brocklebank Dock and the Langton Dock, so that the Brocklebank Dock may form a proper link between the deepened Canada Dock and the modern group north of it, consisting of the Langton, Alexandra, and Hornby docks, whose depth of water, already suitable for modern vessels of fair draught, will be increased by a system of impounding and pumping. The dock known as the South Carriers Dock, lying east of the Brocklebank Dock, is being converted into a graving dock, 800ft. long and 100ft. wide, and to give easy access to this dock for long steamers it has been necessary to make gates 135ft. wide.

The second of the schemes referred to concerned with the south end of the estate, comprised the construction of deep-water docks in the form of branches out of the Queen's and Wapping docks, with improved passages leading to them from the Brunswick Dock, the deepening of the latter dock itself, and the construction of new deep-water entrances from the river at its south-west corner. The latter entrances are completed—though a considerable amount of dredging in the fair-way has yet to be done, and is now in hand—the Brunswick Dock deepened, a new passage 100ft. wide, formed between it and the Coburg Dock, and another of the same width, and in the same line between the Coburg and Queen's docks. The Queen's Branch Dock No. 1, with two-storey sheds on its quays, has also been completed.

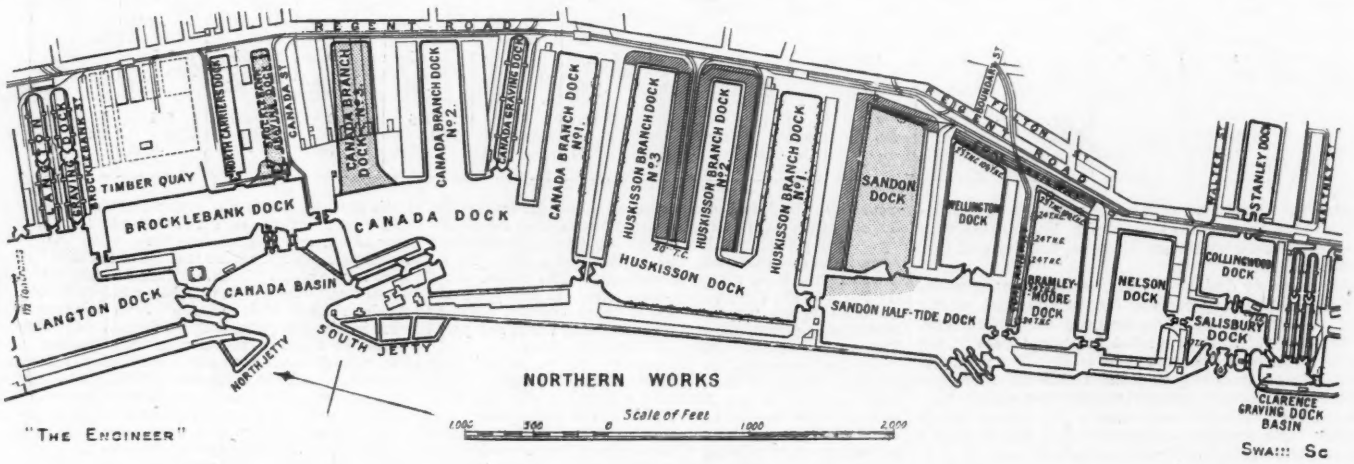
The works now under construction comprise one branch dock and graving dock out of the Queen's Dock, and two branch docks out of the Wapping Dock on the site of the old King's Dock and tobacco warehouses. It is further contemplated to extend the Brunswick Dock by a quay in continuation of the present east quay of that dock on the site of the Union Dock and Brunswick Graving Docks, and so get deep water quayage in a long length there, with wide single-storey sheds. At the Herculaneum Dock, a new graving dock—745ft. long, with entrance 80ft. wide—is being constructed and is approaching completion. The above programme of alterations and additions involves a vast expenditure. Up to the present time, almost six millions have been expended on the scheme since 1891, the estimated cost of the whole of the outlined works amounting to 8½ millions sterling. The following figures as to the estimated ultimate cost, and the expenditure to July 1st of this year, have been courteously supplied by Mr. Anthony G. Lyster, M. Inst. C.E., the engineer-in-chief, under whom this great scheme of improvements to the dock system of Liverpool is being carried out:—

		£
Estimated ultimate total cost as per statement sent to the solicitor on the 14th October, 1904		7,663,705
Ditto, Canada Branch Dock, No. 2		284,000
Additional works in hand or contemplated		551,000
		£8,498,705
Expenditure to 1st July, 1904, as per statement sent to the solicitor, 14th October, 1904	£5,317,514	
Ditto	274,000	
Hornby Spoil Bank	54,235	
Brocklebank Improvements	9,778	
	5,655,527	
	£2,843,178	

We are likewise indebted to Mr. Lyster for the two engravings which we reproduce above. These show well the docks which have been alluded to in the foregoing article, the tinted portions representing the new works.



LIVERPOOL DOCKS



LIVERPOOL DOCKS

UNITED STATES SHIPBUILDING PLANTS SOLD.—On October 25th the Harlan and Hollingsworth plant of the United States Shipbuilding Company at Wilmington, Del., was bought by George R. Sheldon, of New York, representing the re-organisation committee, which has now secured all nine plants. The following are the amounts paid for the several properties:—Bethlehem Steel Company, South Bethlehem, Pa., 7,500,000 dols.; Union Ironworks, San Francisco, Cal., 1,700,000 dols.; Crescent Shipyard, Elizabeth, N. J., 150,000 dols.; Samuel L. Moore and Sons Company, Elizabeth, N. J., 205,000 dols.; Canada Manufacturing Company, Carteret, N. J., 200,000 dols.; Eastern Shipbuilding Company, New London, Conn., 145,000 dols.; Bath Ironworks, Bath, Me., 340,000 dols.; Hyde Windlass Company, Bath, Me., 225,000 dols.; and Harlan and Hollingsworth, Wilmington, Del., 685,000 dols. Add to these figures 50,000 dols. which was paid for the property mortgaged to the Mercantile Trust Company, of New York, and it will be found that the United States Shipbuilding property was sold for 11,200,000 dols., against which was issued 20,000,000 dols. in preferred and common stock and 9,000,000 dols. in bonds, a total of 29,000,000 dols. The capital stock of the subsidiary companies has not yet been sold. Mr. Sheldon's bid of 200,000 dols. for the stock was not deemed satisfactory and the receiver refused to sell it.

THE WORKS OF THE LANCASHIRE DYNAMO AND MOTOR COMPANY, LIMITED, MANCHESTER

(*For description see page 497*)

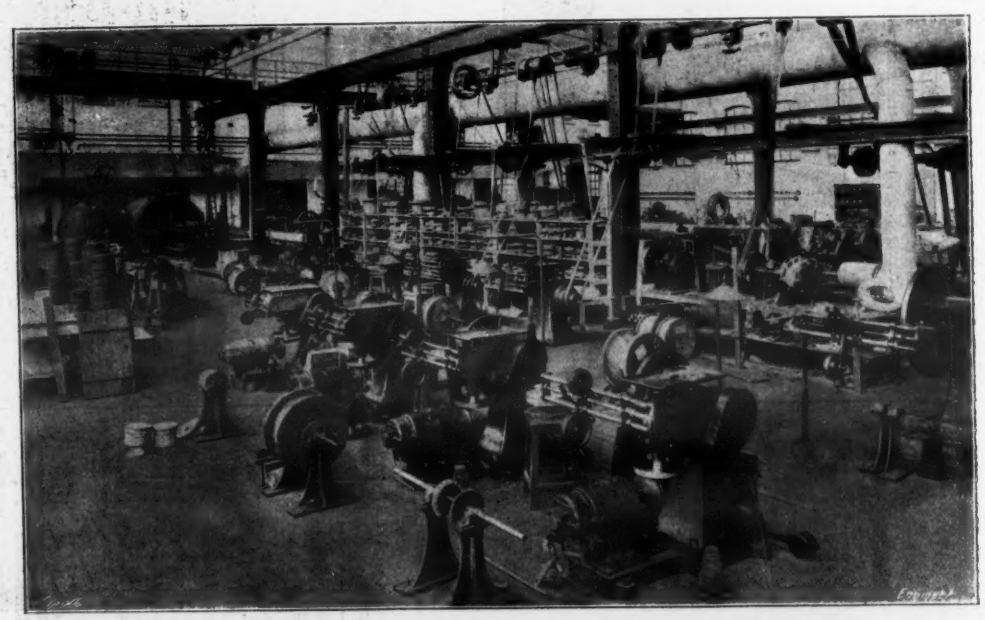


Fig. 9—ELECTRICALLY-DRIVEN WINDING MACHINES

Fig. 10—MOTOR-DRIVEN LATHES

Fig. 11—MACHINE SHOP

Fig. 12—ARMATURE SHOP

LITERATURE.

Le Turbine a Vapore ed a Gas. By Ing. Giuseppe Belluzzo. 413 pages, large 8vo., 22 tables, 300 illustrations. Milan: U. Hoepli.

The preface to this book is dated October, 1904, so that it is the latest shot of the now rapid fusillade of publications on the steam turbine problem. The enterprise of the publishers is evidenced by the date 1905 printed on the title-page. It goes one better than being up to date, and its modernity is surpassed by the ambitious character of its contents and the enthusiasm of the writer. When he is unaware of the details of a construction he is describing, as is not rarely the case, this does not prevent him from going fully into the matter. He surmounts such difficulty by opening his paragraph with the remark: "The construction is probably analogous to . . . ," and then follows, not only a description of the *probable* construction, but also sometimes criticism of it and suggestions for improvement. One would imagine that the ingenuous enthusiasm of youth could not go further than this into the future knowledge to be gathered in 1905 and thereafter; but it also takes another lively direction in the matter of mathematical analysis and demonstration. When a mathematical difficulty presents itself, the facing of which would lead to greater complexity than is deemed wholesome for the readers of the book, it is calmly trodden under foot with an artless and smiling "*supponiamo*"—"let us suppose!" Thus the extremely interesting and important problem of the strength of discs rotating at high speed is attached in connection with the Laval turbine on page 259, and solved by the device of "supposing" that the radial and tangential stresses are equal. Now, from the stage of the investigation reached just before this "supposition" is introduced, it is easy to deduce that these stresses are not equal except for one special form, which it is found impossible in manufacture to follow closely. But the author throughout his book makes references to English, German, French, and American literature, while this particular problem has already been fully and correctly treated in books in these languages. Italian engineers are not worse mathematicians than those of other countries, and should not be put off with suppositious investigations of important practical problems. The game of "let us suppose" is a charming one for playful mathematicians who have to invent posers for matriculation examinees and who have no other connection with practical life; but whenever it is proposed for engineering guidance, no language is too strong for its condemnation, as not only idle and frivolous, but also as fraught with the gravest possibilities of danger.

Ing. Belluzzo's book is profusely and finely illustrated. The second part of it, covering over 150 pages, is devoted to more or less detailed descriptions of the construction, the methods of design, and the working tested results of the turbines on the market under the names of Laval, Seger, Riedler-Stumpf, Parsons, Rateau, Zoelly, and Curtis. Large space is naturally devoted to Laval, Parsons, and Curtis. Here the available statistics of tests are brought together in a useful way, and the author's calculations from these are also given. There is an absence of dimensioned sections, which is probably unavoidable, but in the text are given many useful leading dimensions of the theoretically interesting parts. The last chapter is devoted to the results obtained in marine propulsion. This latter part of the book is the best descriptive treatise on this subject that we have yet examined, putting aside blemishes of the kind already mentioned. According to our opinion, however, the major part of it should stand at the beginning of a treatise on turbines, as we do not believe in students studying the theory of machines before they are made acquainted with the machines as they actually exist.

The first two-thirds of the volume are devoted to the theory of thermodynamics, and its application to turbines. This also is profusely illustrated by diagrams. The treatment is entirely and laboriously graphic. In this respect it is novel and original; but we do not like this kind of novelty. To spend pages of diagram-drawing, diagram explanation, reading, and diagram interpretation in the discovery of simple results that might be easily expressed in a score of words, is tedious in the extreme. To give elaborately-described diagrams, which enable us to calculate graphically h from v, or v from h, in the formula $h = \frac{v^2}{2g}$, and to repeat these time after time throughout the book whenever the same simple calculation recurs, is to nauseate common-sense engineers with graphics run crazy. It is a serious disservice to the cause of the promotion of the utilisation of the beautiful and useful art of graphical calculation. In this volume this procedure is pursued solely from a determination to exclude from the theoretical development all algebraic investigation by equations of the common type. Such determination evidences a sacrosanct enthusiasm for the noble art of graphics, whose birthplace most of us are willing and grateful to acknowledge is Italy; but it shows childishness on the part of the devotee.

Moreover, in most, or very many, diagrams in this book the graphic method is made more difficult and tedious than usual. In the drawings the lines are given one set of names by letters placed at their intersecting points, such letters having no sort of relevance to the things indicated and measured by the lines. In the text another wholly different set of algebraic names, such as h, w, v, d, g, are given to the same things. When a score or so of quantities are involved, the labour of interpretation becomes excessive. One has (1) to learn a lengthy arbitrary algebraic symbolism by heart, generally different for each particular problem; (2) to learn by heart the translation of this symbolism into another equally arbitrary diagram symbolism; (3) to make sure that the algebraic symbols correspond to real physical facts; (4) to make sure that they are properly translated into correct lines on the diagram; (5) to make sure that they are treated in the diagram in accordance with true physical laws; (6) to see that the geometrical deductions are correct; (7) to check the re-translation of the geometrical results into algebraic symbolism; and (8) to understand these results as physical facts from the final translation of the algebraic into ordinary language. Now, Italian is a facile language, and Mark Twain could not make a fool of it as he did of German. But the simplest and straightest of language will not stand the strain of the above process. Long before we arrive at the Eighthly we have forgotten the alphabet, and have to go back and begin all over again.

Graphic calculation is eminently well suited for the study of the relations between directed quantities, and sometimes for arithmetic operations arising directly from these relations. But to invent out-of-the-way graphic constructions for the simplest and easiest arithmetic and algebraic reckonings simply for the sake of avoiding the use of arithmetic and algebra, even in their most elementary forms, is both fantastic and clumsy. Illustrations of such fantasy occur constantly throughout the first portions of Signor Belluzzo's book. If all that is certain to be already familiar in its usual form to any likely reader of the book were omitted, the bulk of this first portion would be reduced by one-half, and the reader would reach the really useful portions without that feeling of painful weariness that results from efforts gratuitously and uselessly imposed.

Besides, presumably out of sheer weariness from the mass of non-physical representations heaped into his diagram, the author himself sometimes endeavours to reach a conclusion by a short cut, of the truth of which he gives no evidence. Thus, on page 125, where he wishes to establish a relation between the loss of *vis viva* in the relative motion through the wheel and the difference of the squares of the peripheral speeds of the entrance and discharge tips of the blades, he quite suddenly—apparently in despair of ever reaching a conclusion without adopting violent means to secure one—declares quite dogmatically that K G is the entrance relative velocity of the steam; actually he calls it the "relative" velocity without further specification, but it is discovered on the following page that he means that at entrance. Now the two points K and G on his diagram have been located quite independently by somewhat complex processes, neither of which have any direct dependence upon the conditions at entrance. Whether K G is actually what he states it to be we do not know and do not care; but he makes use of this bald dogmatic assertion, which he proffers without proof or comment, and which *à priori* has little chance of being true, in order to arrive at a conclusion which forms the whole base of the distinction between "re-action" and "impulse" turbines, and of the measurement of what he calls the "grade of re-action."

Another sample of slurring over either difficulty or want of exact knowledge is seen on page 294. Here it is stated that the worst leakage losses in a Parsons turbine "are those along the inside cylindrical surface of the casing, and it is sought to minimise these by an ingenious device shown in Figs. 232 and 234." Now, this is quite an exciting announcement, and one naturally turns with eagerness to examine the Figs. 232 and 234. They are found to be perfectly simple sketches, having no reference or bearing upon the leakage referred to, or, indeed, any other leakage. No other illustrations in the chapter show any device of the kind mentioned; no further reference than the above is to be found elsewhere in the text. The "ingenious device" will remain a mystery, and the curiosity so cruelly aroused will remain unsatisfied, until Messrs. U. Hoepli publish a new and revised edition.

The theoretical thermodynamics of gases as well as that of steam is expounded in the early chapters. This seems to be the extent of the justification for putting upon the title-page "Steam *and Gas* Turbines." In subsequent chapters, wherever a statement is equally applicable to steam and gas, the phrase "steam or gas" is used. As this occurs at a thousand places, the iteration of the same phrase is wearisome and annoying, and hardly forms an excuse for the title. No gas turbines actually constructed are described or referred to. But we should not omit to mention that the author expresses his confident conviction that before long the gas turbine will drive both piston and wheel steam engines, and also internal-combustion piston engines, out of the market. He also advises all the makers of steam turbines as to the constructive improvements they should adopt.

The book has many excellent features and is well worth having on the shelves of the turbine engineer. The severity of some of our criticism is not to be construed as a denial of merit or of a just meed of praise. It is due rather to the irritation of disappointment caused by the contrast between the pretentious character of the book and the failure to find in its contents anything novel that is not useless, or much that is useful that is not in some degree spoilt by careless treatment.

BOOKS RECEIVED.

The Analytical Theory of Light. By James Walker. London: C. J. Clay and Son. Price 15s.

Billiards Mathematically Treated. By G. W. Hemming, K.C. London: Macmillan and Co., Limited. Price 3s. 6d.

Einleitung in Die Theoretischie Elektrizitatslehre. Von Dr. Ignaz Wallentin. Leipzig: Druck und Verlag. Von B. G. Teubner.

Modern Tariff History: Germany, United States, France. By Percy Ashley, M.A. London: John Murray, Albemarle-street. Price 10s. 6d.

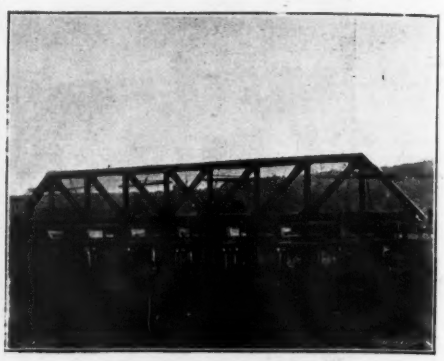
A Further Course of Practical Science—Mechanics, Hydrostatics, and Heat. By J. H. Leonard and W. H. Salmon. London: John Murray, Albemarle-street. Price 2s.

Dampfturbinen Entwickung Systeme Bau und Verwendung. Von Wilhelm Gentsch. London: Williams and Norgate, 14, Henrietta-street, Covent-garden, W.C. Price 16s.

Encyclopædia of Trade between the United States of America and France. By G. Hanotaux. London: Archibald Constable and Co., Limited, 16, James-street, Haymarket. Price 21s. net.

BRIDGE AT STOKE CANON.

The accompanying engravings illustrate the work carried out in connection with the reconstruction of North River Bridge, carrying the Great Western Railway over the river Exe, at Stoke Canon, near Exeter. The old timber structure of six spans was built about sixty years ago, and in the last week in March of this year the contract was let to the Patent

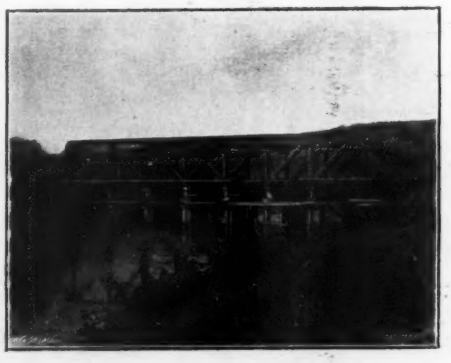


FIRST GIRDER ON TEMPORARY STAGE

Shaft and Axletree Company, Limited, of Wednesbury, to supply steelwork for a single span of 130ft., the contract for the work at site being placed in the hands of Mr. H. A. S. Fraser, of Whitchurch, Cardiff. The new superstructure, with the lines of rails, was erected on temporary staging clear of the old bridge, the total weight being close on 300 tons,

CONSTRUCTION OF SECOND GIRDER

and on Sunday, October 23rd, half of the old bridge was taken down and the new bridge moved in half way, and the up line opened for traffic on the new work. On Sunday, October 30th, there being no traffic between 10.10 a.m. and 12.15 p.m., the bridge was moved into its final position; the time occupied in freeing the girders, traversing into position,



GIRDER READY FOR LOWERIN

re-packing ready for traffic, being 1 hour and 40 minutes, the 12.8 p.m. express from Exeter to Bristol being the first train to pass over the bridge. The company put in the foundations and built the abutments. Owing to the number of large boulders in the bed of the river, the excavation and concreting below water was done by divers, the work being carried out by Mr. T. H. Gibbons, engineer of the Plymouth division.

Institution of Electrical Engineers: Manchester Students' Section.—The following meetings and visits for the session 1904-1905 have been arranged:—Meetings at the Municipal School of Technology, Sackville-street, Manchester, at 7.30 p.m.—1904: November 25th, H. C. Jenkins, "Electric Power in Machine Shops;" December 16th, E. D. S. Shelmerdine, "Battery and Booster-working." 1905: January 13th, A. E. Jepson, "Electric Heating;" February 3rd, V. H. Mahler, "The Electric Equipment of Automobiles;" February 24th, Mr. Buttenshaw, "Metallography;" March 17th, C. R. St. John, "High-tension Switch Gear;" April 7th, M. Jennison, "Electric Cranes" (this meeting will, by the kind permission of the Principal, be held at the Royal Technical Institute, Salford). Visits.—1904: December 3rd, Manchester Corporation Sub-stations; December 17th, the Manchester Liners (s.s. Manchester City), Salford Docks. 1905: January 14th, Messrs. Joseph Adamson and Co., Limited, Hyde; February 4th, Messrs. Browett, Lindley and Co., Patricroft.

THE IRON AND STEEL INSTITUTE.

NEW YORK POWER STATIONS.

We mentioned in our account of the business proceedings of the Institution that one of the principal excursions in New York was to the rapid transit subway and the power station of the interborough Rapid Transit Company, which supplies it with electricity. We propose to enlarge a little on that short account before dealing with other excursions of the Institute.

The construction of the subway was commenced more than four years ago, and has presented some difficult engineering problems. It follows the line of certain of the busiest streets of the city, and lies beneath the tracks of the busiest electric tram lines. Starting from its southern terminus, City Hall Station, close to the Post-office, and not far from the famous Wall-street with whose reputation every one is familiar, it continues as a four-track line direct to the Grand Central Station on 42nd-street, there turns westward to Broadway, and continues on through that thoroughfare to 104th-street, a distance of seven miles. Here the four tracks divide; one double-track and three-track line continues along Broadway to Kingsbridge, while another double-track line crosses under the Harlem River and proceeds to Bronx Park and the Zoological Gardens over a three-track viaduct. Each of these branches is seven miles long, giving a total length to the whole system of twenty-one miles. The northerly ends of the three-track line are to be elevated structures for a combined distance of 7·14 miles, and there is also to be a short length of high steel viaduct one-half mile long, crossing the Manhattan Valley, an abrupt depression on the west side. This viaduct consists of a single arched span over 125th-street, measuring 170ft. between the skewbacks, and a trestle approach on either side of it. All the remainder will be underground.

Over the two centre tracks express trains will be worked throughout the day, running on shorter headway during what are termed the rush hours, *i.e.*, the periods from 7.30 to 9.30 in the morning and from 4.30 to 6.30 in the evening. During these latter periods the expresses will be run every two minutes and local trains every minute. Expresses will stop at three stations between the Brooklyn Bridge and 96th-street and all stations beyond. They will run at an average speed of at least 30 miles an hour. The locals running on the two outer tracks will stop at all stations, these being about a quarter of a mile apart, and will make an average speed of about 14 or 18 miles an hour, including stops. Local stations have platforms outside of the local tracks, and express trains will pass through the centre without stopping, but at the express stations bridges will be erected over the tracks, so that passengers may pass from the local station platform to the express station platform.

Express trains will consist of eight cars, with a seating capacity of 52 each, and standing room for 100 more, making the capacity of a single train 1200, and the number of persons that can be carried during the two rush hours 72,000. In the same period local trains of five cars each will handle a maximum of 90,000 passengers. All through the day the express trains will be run every fifteen minutes, and the locals every three minutes. After the rush hours at night the express trains will run every half hour until midnight. The locals will run every three minutes, and from 1 to 4 a.m. every ten minutes.

The completed subway forms a steel structure rectangular in shape and built in an open cutting. The first step in its construction, throughout the greater part of its length was to tear up the surface of the street and excavate it to the depth required, which averages about 20ft. Upon the bottom of the excavation a solid floor of concrete was spread, and on this floor were erected at intervals of about 5ft., running transversely to the line of the street, frames of steel beams securely riveted together. These frames were designed to take the load of the street and the thrust of the side earth. Between these frames or ribs a concrete wall and a concrete roof is built, and between the tracks and supporting the roof are rows of light steel columns. The whole tunnel is rendered waterproof by a complete envelope of waterproof felt put down in layers and thoroughly coated with tar. The subway is carried under the Harlem River in a two-track tunnel, and the tunnel beneath the East River will take about three years to construct. The new extension, which will be a two-track structure, will start from the end of the present subway at the intersection of Park Row with Broadway, and will extend beneath Broadway to the Battery, where there will be a loop for the use of the Manhattan trains, which will make the return trip to Harlem and beyond.

One of the most impressive features of the subway was its cost. The accepted bids for the contracts of the four sections into which the original work was divided were:—For section I., £3,000,000; for section II., £5,200,000; for section III., £6,400,000; and for section IV., £7,000,000. In addition to this £200,000 was allowed for terminals and the purchasing of real estate.

The power station is situated on the North River, between 58th and 59th-streets. It is built to contain eleven 5000-kilowatt engine-driven alternators to furnish power for subway cars, and four 1250-kilowatt turbine-driven alternators for supplying light in the subway. The building is 201ft. in width and 690ft. in length. The property extends 110ft. west of the present building to the North River, leaving space for two additional units. The power station machinery is arranged in six units, each unit consisting of one stack, twelve boilers and two engines.

The engines were made by the Allis-Chalmers Company. They have each two horizontal high-pressure cylinders 42in. in diameter, and two vertical low-pressure cylinders 86in. in diameter. The high-pressure cylinders are supplied with poppet valves so that superheated steam may be used, and the low-pressure cylinders with Corliss valves. Each engine is rated at 7500 indicated horse-power at 75 revolutions a minute, with 175 lb. steam pressure at the throttle and 26in. of vacuum. The guaranteed steam consumption is 12½ lb. of dry steam per indicated horse-power per hour, this steam consumption to include all steam used in jackets and re-heaters.

Each engine is provided with an independent condensing equipment, consisting of one compound vertical crank and fly-wheel circulating pump, one crank and fly-wheel dry-air pump, and a condensing cone, or barometric condenser, placed immediately below each of the low-pressure cylinders, at a height of about 40ft. above extreme high water in the discharge tunnel.

The boiler plant for the present installation consists of sixty Babcock and Wilcox horizontal water-tube boilers, each having 6000 square feet of heating surface. These boilers are all placed on one floor in batteries of two boilers each, and are supported on the steel columns of the building. Provision is made for superheaters. Grates for hand firing are installed for the first thirty-six boilers and automatic stokers for twelve boilers. Each boiler has 100 square feet of grate area. Buckwheat anthracite is burned.

Coal is deposited on the floor in front of the boilers through iron shoots from the coal bunkers above the boilers. Provision is made for twenty fuel economisers for heating the feed-water. These are to be placed immediately above the boilers, with a main flue on the same level. The fuel gases from sets of three boilers pass through each economiser, with dampers and by-pass flues, so that the gases may be passed directly to the stacks. Before entering the economisers, the feed-water is passed through auxiliary heaters, which receive heat from the exhaust steam, from the steam-driven boiler feed pumps and circulating pumps.

Twenty blowers are used to furnish forced draught under the grates, each having a capacity of 56,000 cubic feet of air per minute, at a pressure equivalent to 2in. of water. They are each driven by a 50 horse-power compound steam engine.

Ten steam-driven vertical feed pumps are provided for the present installation.

The coal is unloaded from barges by a movable coal tower, which runs on a track placed on the pier at the foot of 58th-street. It is taken from the barge by a steel clam shell bucket, which hoists it to the top of the tower. This bucket is raised by a 200 horse-power direct-current 250-volt motor directly connected to the hoisting drum, and is unloaded into a hopper, which delivers the coal to crushing rolls, thence to weighing hoppers. Beneath the track upon which the tower runs is a belt conveyor, upon which the coal is delivered from the weighing hoppers. This conveyor takes it to the bulkhead line and unloads it upon a similar belt conveyor, which runs through a tunnel under 58th-street to the westerly end of the power station, where the coal is elevated by a series of inclined conveyor belts to the level of the top of the coal bunkers.

The bunkers have a capacity of 18,000 tons; they are of steel construction, with concrete arches and lined with cement. Iron shoots take the coal from the bottom of the bunkers to the firing floor in front of the boilers.

The nine 5000-kilowatt Westinghouse alternators ordered are designed for delivering three-phase current at 11,000 volts, 25 cycles, at 75 revolutions a minute.

Another interesting power station visited in New York is that of the New York Edison Company, which supplies an area of seventeen square miles with electricity, mainly for lighting. The largest part of the supply is generated at 6600 volts, three-phase 25 cycles, and is transformed at eighteen sub-stations to direct current for consumption. The sub-stations have also large storage batteries of 6000 ampère-hours capacity for three hours, to ensure a steady and constant supply.

The station building is 272ft. long by 197ft. wide, and is divided by a longitudinal wall into engine and boiler-house. It contains sixteen vertical reciprocating engine and generator units of 8000 horse-power each, arranged in two rows, and fifty-six boilers of 650 horse-power each. The engines are of the three-cylinder, compound, double-acting type, with the high-pressure cylinder between the two low-pressures. When operating with a steam pressure of 180 lb. at the throttle and 27in. vacuum at the low-pressure cylinder, they will develop about 5500 horse-power on less than 12½ lb. of dry steam per indicated horse-power hour, and are capable of developing 10,000 horse-power at maximum cut-off. Some of the principal data are:—Cylinder diameters, one at 43·5in. and two at 75·5in.; cylinder ratio, 6·02:1; crank angles, 101 deg., 126 deg., 133 deg.; valves, Poppet high, Corliss low; diameter piston-rods, 9in.; hollow shaft, 35ft. long, 29⅜in. maximum diameter; total weight on bearings, 490,000 lb.; fly-wheel diameter, 23ft.; weight, 72 tons.

Each engine exhausts into an individual surface condenser, containing 9200 square feet of cooling surface. Intake and overflow tunnels for the circulating water extend from the bulkhead under each row of engines. The air and circulating pumps for the condensers are operated by a 16in. steam cylinder with Corliss cut-off gear. The steam and pump cylinders are arranged in tandem, with a common stroke of 24in.

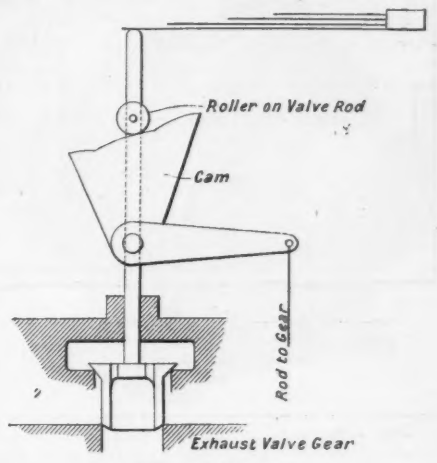
The generators are of the revolving field type, have forty poles, and when operating at 75 revolutions per minute generate 25-cycle, three-phase current at 6600 volts. They have a normal rating of 3500 kilowatts each, and will carry 5000 kilowatts for short periods. After 11 units of this type had been installed, developments in the steam turbine led to the decision to install turbo-generators in the balance of the station. One Curtis turbine general electric generator unit of 5000 kilowatts has been erected, and two more are in process of construction.

The bus bars and high-tension switches for generators and feeders are placed in galleries designed for the purpose at the west end of the main operating room. On the third floor is the operating gallery, from which the operator has a full view of the engine and dynamo room. On this gallery are situated the low-tension pilot switches, which control all the high-tension switches, and on marble panels above these are all the indicating and recording instruments necessary for the working of the station.

The boiler plant consists of fifty-six boilers of the Babcock and Wilcox type, arranged in two tiers, with coal bunkers above. Each boiler contains 6500 square feet of heating surface, and has a grate surface of 110 square feet, thus giving the ratio of 59 : 1 between heating and grate surface. Twenty are equipped with automatic stokers, and thirty-six with flat grates for hand-firing. The coal-receiving towers and ash pocket are located on the bulkhead extending along the entire river front of the station.

The fuel used is known as No. 2 bituminous slack, burnt on perforated grates with forced draught. The appearance of the fire is remarkable, as the air, entering through the perforations, throws up little fountains of burning coal all over its surface.

The engines, as the particulars already given show, are of great size. They were built by Westinghouse, Church, Kerr and Co., and drive alternators built by the General Electric Company. The admission valves for the two low-pressure cylinders are of the Corliss type; those for the high-pressure cylinder are double-seated drop valves



DROP VALVE GEAR

worked by trip on the admission side and by cams on the exhaust side. The valves on the lower end are placed in a valve chest, brought out to the side of the cylinder, whilst the other pair are in the top cover. The valves are closed by flat springs, the general arrangement of the exhaust valves being as shown in the accompanying sketch.

THE LANCASHIRE DYNAMO AND MOTOR COMPANY'S WORKS.

Among new companies which have made a good start and excellent progress in a short time may be mentioned the Lancashire Dynamo and Motor Co., of Trafford Park, Manchester. This company was registered in April, 1899, and the works were started in July, 1900, with some thirty men. As early as March, 1903, the first extension was commenced. Then again there were two further extensions, both begun in September, 1903. Now, the area covered by the works buildings is some 16,250 square yards, and nearly 500 men are employed. The company was formed for the purpose of manufacturing standard sizes of motors and dynamos in large quantities on the interchangeable system, as it appeared to the founders that there was a big chance for a company worked on these lines. Some idea of the scale on which the business is carried out may be gathered from the facts that with machines up to 40 horse-power no less than 100 are put through the shops at one time; from 40 to 100 horse-power twenty-five are put in hand, and for higher horse-powers than this, as many as may be required, or as may seem desirable. It will readily be appreciated that action such as this will conduce to economy in manufacture. We are informed that the company has twenty-eight standard sizes in continuous-current machines, the powers of these varying from 1 to 1000 kilowatts. It does not, however, by any means confine its attentions to continuous-current machines. There are twenty-one standard sizes in induction motors, the powers varying from 1 horse-power up to 750 horse-power, and also a number of standard sizes of alternators, which range up to 1500 kilowatts in capacity.

During the time that its permanent works were under construction, the company took temporary works in Croft-street, Pendleton, with temporary offices in the Corn Exchange in Manchester. At these offices all the necessary drawings were prepared and at the Croft-street Works the patterns for all the standard sizes of motors, and for the motors to be used in driving the Trafford Park Works, were constructed. This enabled an effective start to be made in the permanent works as soon as these were in a habitable condition, and, no doubt, made the company a money-earning concern long before it would otherwise have been. The works in Trafford Park have been equipped with some of the latest and best machine tools. Indeed, we should say that but few, if any, engineering shops are better provided in this respect. Considerable skill has been exercised, also, in the disposition and arrangement of these tools. In some instances they are grouped and run off line shafting, which, in its turn, is driven by motors. In a large number of instances, however, single tools are connected direct to their own

motors, the wires being run to them in pipes at or below the floor level. We noticed even that some of the smaller machines were worked in this manner. These were in nearly every case well out in the shop and away from either wall, in such a position, in fact, that it would have been most inconvenient to use belting. The company makes a speciality of variable speed motors for machine driving, a variation in speed of 3 to 1 being obtained in the motors. The manner in which this is brought about is by varying the resistance in the shunt field. We saw this method at work on a number of motors in the shops. There is the ordinary starting resistance and automatic cut out, and in addition there is a rheostat, taking up but very small space and provided with a contact arm and a number of—some fifty

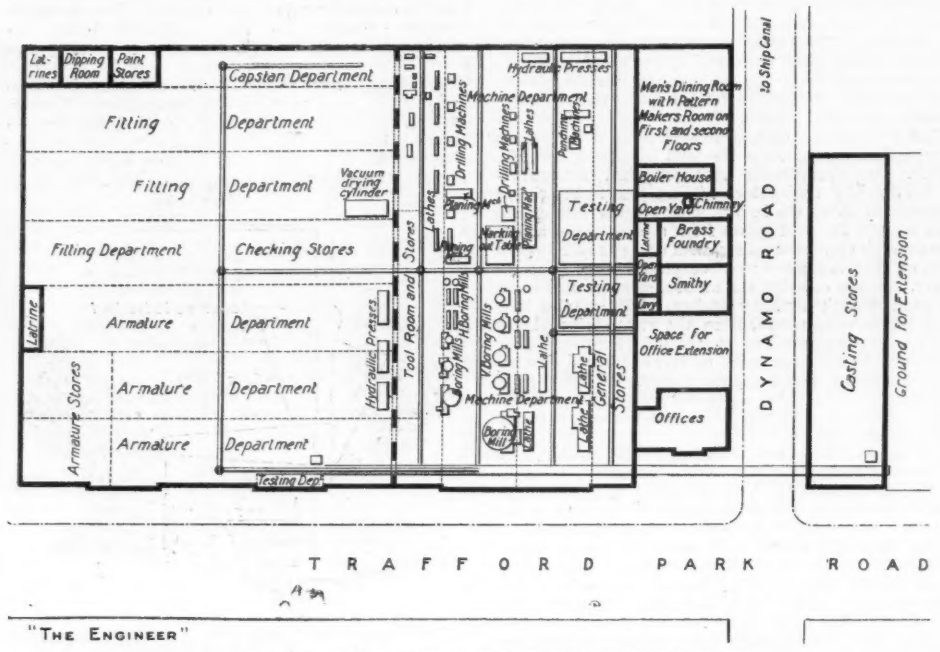


FIG. 1—THE LANCASHIRE DYNAMO AND MOTOR COMPANY'S WORKS

—contacts. This rheostat is inserted in the shunt field, and the makers inform us that they can obtain a variation in speed of the motor by manipulation of this rheostat of, say, from 300 to 900 revolutions per minute with but small variation in the efficiency of the motor over the whole of this range. In support of this assertion, and as a comparison of the different methods of control, they have supplied us with a set of efficiency curves, which we reproduce herewith in Fig. 2. In this the curve marked A shows the efficiency of a motor capable of developing 15 brake horse-power at any speed between 300 and 900 revolutions per minute, all the variation being obtained by shunt control only. It will be seen that the efficiency is very fairly high all through, and that it is but slightly less efficient at the slower speed—this notwithstanding that the motor was yielding 15 brake horse-power all the time. Curve B relates to the same sized motor, only in this case the load was dropped proportionately to the speed, so that at 300 revolutions per minute only five horse-power were being developed. The motor in this case was maintaining a constant torque throughout

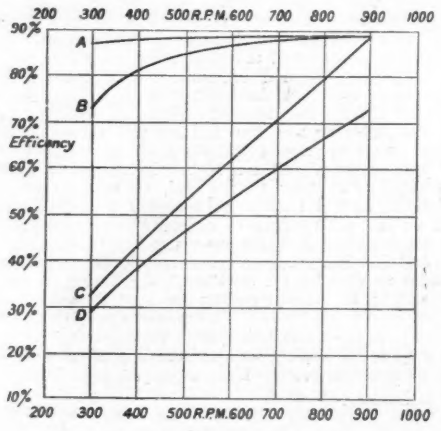


FIG. 2—EFFICIENCY CURVES

its range of speed. Curve D is the same size of motor arranged for controlling the speed by means of a resistance in series with the armature, the armature being capable of developing 15 brake horse-power at 300 revolutions per minute with all the resistance in series with the armature. In this case the motor has to have a winding on the armature suitable for developing 45 horse-power at its full speed. Consequently, when running at 900 revolutions per minute and only developing 15 brake horse-power, the motor is only working at one-third its load. This accounts for the low efficiency. Naturally the motor in curve D has a much larger core loss than the motor in curve A when running towards top speed. Curve C, on the other hand, is that of a smaller sized motor wound to develop 15 brake horse-power at 900 revolutions per minute, all speed variation being obtained by inserting resistance in series with the armature. This motor would, however, only be capable of developing 5 brake horse-power at 300 revolutions per minute. In a few words, curves A and D represent variable torque machines such as would be used on lathes, &c., which are removing practically a constant amount of metal whatever the speed may be, while curves B and C are given to show the difference in efficiency in the control of a constant torque machine.

The original works of the company in Trafford Park consisted of two bays, each some 240ft. long by 65ft. wide. In one of these there are two electric cranes, one of these having a capacity of 20 tons, and the other of 10 tons. Both are by Vaughan, of Manchester, and both are provided with three motors. The 20-ton crane can be run along to the end of the building so as to come over a railway of standard gauge, which is a siding connected with the Ship Canal Railway. This siding enters the works over a weighbridge made by Hodgson. There is, therefore, an excellent means of bringing material on to the works, and of taking away finished articles. The Ship Canal, also, is but a short distance from the works, which, of course, adds to the facilities.

The buildings have brick sides and ends, and upright lattice girders to help to carry the roof and galleries, and also to provide support for the rails on which run the overhead travellers. The roof is made up of light angles and plates, and is partially glazed, the shop illumination being upon the whole excellent, though under the galleries it is not always as good as it might be. There are four sets of small tram lines running down these two bays already mentioned, these being cross connected in the middle, and provided with turntables. A glance at the accompanying plan will show the disposition of these shops, &c., as well as the other portions of the works to be

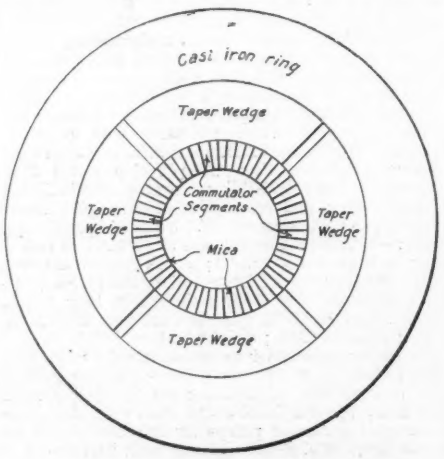


FIG. 3—COMMUTATOR MANUFACTURE

hereafter mentioned. The plan also shows the positions of the principal machines and the general arrangement of what is known as the machine department. It may be here remarked that the works has no central power plant of its own. It was early decided to take advantage of the near proximity of the Trafford Power and Light Supply Company, and we understand that electricity is obtained at a very reasonable figure. This, of course, simplified the arrangements, it being only necessary to provide the required mains and switchboards for the power and lighting circuits. This supply company, we may add, has both alternating and continuous-current systems, the voltage being 250 for lighting and 250 and 500 for power. It will therefore be seen that the manufacturing company has a considerable choice of which to avail itself.

In the centre of the length of one of the bays, and rather to one side, is the testing department, and here there are two testing beds, one being about 40ft. by 40ft. and the other about 40ft. by 30ft. In these two bays the major part of the heavy machining and erection is carried out. Here, too, are the painting and finishing benches. A noticeable feature throughout the shops is the use made of multiple drills and horizontal boring mills. There is one fine specimen of the latter machine. It is by Smith and Coventry, and can take in work up to some 18ft. in diameter and 9ft. high. It is like many of the other tools, as already mentioned, driven by a variable speed motor with shunt control. We noticed throughout the works the general excellence of the various machines, the great majority of which were of British manufacture. We noticed especially the names Craven Brothers, Kendall and Gent, Herbert, and Smith and Coventry. Wooden pulleys are much in evidence.

The extensions to the older shops took the form of bays at right angles to the existing bays. They have saw-teeth roofs, and are well lighted. They are heated on the plenum system by the Sturtevant Company's plant, galvanised zinc trucks being taken to various parts of the buildings, the air being driven over steam-heated coils by means of a fan. In one of the new bays, which for convenience we shall call No. I., there are a number of capstan and automatic machines, mostly by Herbert's, of Coventry. This bay, as are all the others, is served by a 5-ton overhead travelling crane, made by Cravens Brothers. There are, moreover, small tramlines, with turntables, running in various directions. All the machines in this No. I. bay are driven by one motor working on a line of shafting, and thence by belts on to countershafting. The company has by no means put in separate motors for the pleasure of doing so. It has evidently carefully calculated out the best method to employ without being particularly prejudiced in one direction or the other. At the far end of this No. I. bay there is a space divisioned off by means of

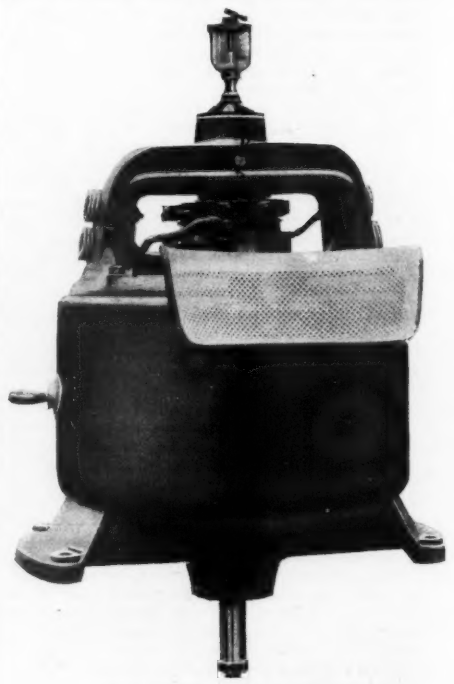


FIG. 4—VERTICAL SPINDLE MOTOR

a screen of expanded metal, and in this are at present stored a number of stock machines. In this bay is also carried out the fitting together of dynamo and motor frames, fettling, chipping, &c. All the new bays have wood block floors.

The second bay is devoted chiefly to fitting and erecting. Here, too, the pole pieces are fitted on to the poles. These pole pieces are made up of laminated stampings, the stampings being $\frac{1}{16}$in. in thickness. They are kept together by means of gun-metal end pieces and pins, the pins traversing the laminations and being rivetted over the gun-metal end pieces. All sizes of machines save the very biggest are dealt with in this bay. Between it and the bay next to it—No. III.—is situated a foreman's office, placed on the middle length of the bays and glazed all round, so that there is no difficulty in seeing all over the two shops. In No. III. bay the field coils are fitted on and some of the machines are assembled. At one end there is a partitioned-off portion used as a store for end bearings and rings, spindles, spiders, bearing brasses, &c. The other end of the bay and part of the same end of bay No. IV. is railed off, by means of an expanded metal partition, a considerable space devoted to the manufacture, taping, &c., of former-wound armature coils, the making being carried out by men and boys and the taping by girls. The former-wound coils, we noticed, are put together by hand, and are not wound in machines as in many other shops. In a further railed-off space coloured sleeves are slipped over the various ends of the taped coils, to show which are which.

The remainder of bay No. IV. is given up to the winding of field coils. This portion of the works is shown in Fig. 9, page 493. A line of small winding machines will be noticed in the foreground. Each machine is friction-driven by a 1¼ horse-power motor working at 750 revolutions per minute, and at 500 volts. The speed of the winding can be altered at will by

adjusting the position of the friction wheel with regard to the driving disc. An ingenious method of keeping the wire taut by threading it backwards and forwards over two friction wheels is employed in these machines, further tension being, if desired, put on by applying a brake to the spool off which the wire is being wound. There are other styles of winding machines, some of these—the smaller sizes—being driven by belting off shafting. There is a mechanical counter on each machine. The field coils, as are those for the armatures, are all wound on formers. When finished they are taped and varnished. All coils are, before being put into machines, dried in the large cylindrical vacuum steam drying cylinder, which may be seen at the far end of this bay, as shown in Fig. 9. It will be observed that the door of the vessel is shown removed. In this bay also the assembling of the big brush carrying rings for the larger sizes of machines is performed.

Bay No. V. is given up to the manufacture of commutators and the winding of armatures. There are several noticeable points in the methods employed by this company for these processes. The copper sectors going to make up the commutator are arranged with mica between them, and are then clamped together by means of four tapered wedges acting inside a cast iron ring, as is shown in Fig. 3. The subsequent operations of turning the ends and boring the inside are carried out with the sectors held together in this manner. Another point we noticed was that for certain sizes of machines each commutator sector is drilled, and has sweated into it a piece of flexible for jointing on to the armature winding. The method of sweating these joints, *i.e.*, those between the flexible wire and the armature winding, is worthy of mention. A circular cast iron trough of the proper size is provided, the size, of course, varying with the different machines. The circular hole in the centre of the trough is in each case large enough to allow the commutator to pass through. This trough is filled with molten solder, and the armature, after the joints have been properly assembled in clips, is gently lowered, so that the commutator goes through the centre of the trough, and the armature is so guided that the joints to be soldered descend into the molten solder. The company's officials informed us that not only does this make satisfactory joints, but that the process is very considerably cheaper than any other yet tried. We saw the operation carried out several times on different armatures, and contrary to what might perhaps have been looked for, the insulation was not injured by the heat. Moreover, the work done was neat and regular.

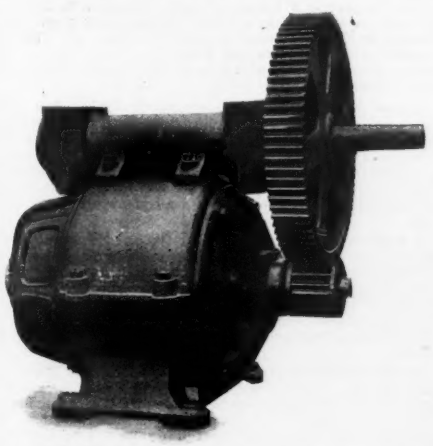


Fig 6—ENCLOSED MOTOR AND GEARING

Bay VI., and last, contains, at one end, a stores for commutators, armatures, &c., and in the remainder of the shop the armatures are completed and partially tested. We may here state that the armatures are tested twice—once in this shop for insulation, when they are labelled as being sound or not, and again in the machine. A further label is put on after this process, and the shipping clerk is bound to be in possession of these two labels, showing the armature to be in serviceable condition, before he allows it to leave the works. The testing plant in this shop consists of cells, with boosters for charging, and a variable excitation alternator, capable of developing pressures up to 15,000 volts. This is used principally for testing materials. There are, of course, the necessary galvanometers, resistances, &c., as well.

We noticed that the armature core plates, when assembled in a machine, had several shallow channels turned in them where it was desired to wind on the retaining bands. These channels were of such depth that the bands did not project above the periphery of the core plates, so that no allowance has to be made for them in the air gap. We observed, also, that gas ovens were used for heating the irons, solder, &c., affording a useful means of performing these operations. In this bay is the switchboard for the extensions. It is a large board, and the circuits are all provided with overload cut-outs with magnetic blow-outs.

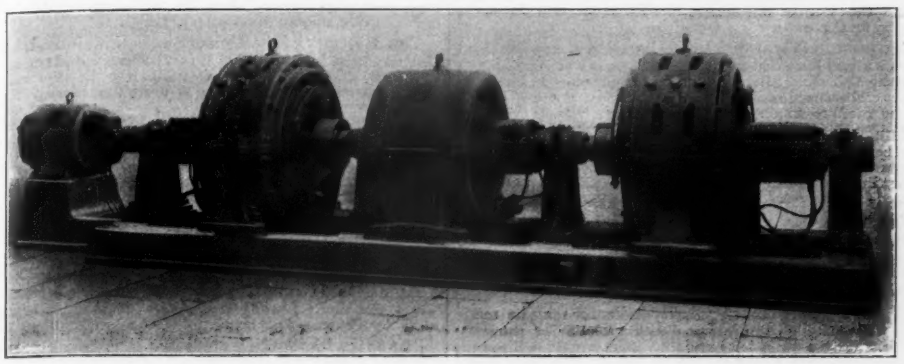


Fig. 5—AUTOMATIC REVERSIBLE THREE-WIRE BOOSTER

The tool room, which, with its accompanying stores, is situated under one of the galleries, and is near both the old and the new buildings, is well laid out and conducted. Perhaps it might have been better lighted, but we should say that this is its only fault. The work carried out in it, despite this, is excellent, and there is a complete checking system, by which it is known at a glance in what part of the shops and in what particular workman's possession any tool is.

A gallery traverses three sides of the original shops. This is put to various uses. In one part the slots in the armatures are made to gauge in a machine which draws a cutting tool of the right size through the slots one after another. Near by this machine the packing cases are made. The remainder of the gallery is practically devoted to the manufacture of brush gear, &c. On a half landing, to which access may either be had from the gallery or the ground level, is the pattern shop, heated on the plenum system and furnished with power-driven lathes, saws, planers, &c.

In a separate building is the brass foundry. The company does not do any of its own steel casting. Close by is a Lancashire boiler devoted to heating the building, a men's mess-room, and a smiths' shop with two fires and a power hammer motor driven.

Detached from the main building is another, which is at present devoted to the storing of castings. Here, too, are two automatic saws, and there is also a 5-ton electric crane. It is evidently intended to use this building for other purposes in the near future, and to extend it. We noticed that the side towards the vacant property of the company is only at present temporarily boarded up.

The accompanying illustrations and those on page 493 give first of all a good idea of some of the types of machines made by the company, and next some good views of portions of the works. The latter speak for themselves. Regarding the former we may say that Fig. 7 represents a standard type of induction motor fitted with a gaslight cover over its slip rings—a machine which the company recommends for colliery work. Fig. 8 shows an open-type motor driving a centrifugal pump. This actual plant was supplied to the Cape-town Corporation. Fig. 6 is a standard type continuous-current motor fitted with a single reduction gear, the bearings on the back shaft being self-oiling and having spherical seats. Fig. 5 shows one of the Turnbull and McLeod patented automatic reversible three-wire booster, this being one of the company's special manufactures. This particular machine was supplied to the North-Eastern Railway Company for its Darlington Works. It is used on a three-wire system, where 70-ton cranes are working on each side of the system, and, in conjunction with a battery, it is said to prevent any serious variation taking place due to the suddenly-changing load and large out-of-balance currents. Fig. 4 is a motor with its spindle arranged vertically. A number of these have been supplied for operating in sewage works. The foregoing gives some idea of the scope of the Company's operations, though they represent but a small part of the whole.

We have drawn attention to several of the distinguishing features of the machines as made by this company

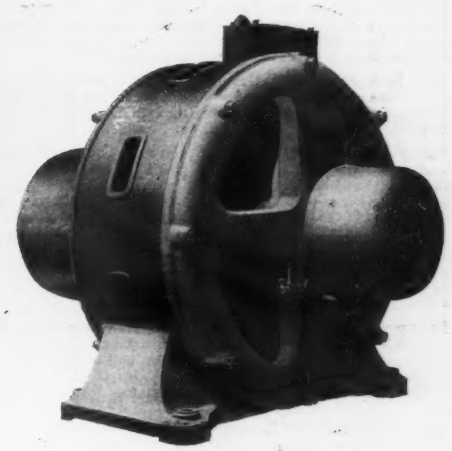


Fig. 7—INDUCTION MOTOR

There are others which, perhaps, we may usefully mention. Of course, the armatures are built up on a casting which also carries the commutator. This method of construction is in one manner or another practically universal now-a-days. All the spindles where they go into the bearings are ground. This also is an excellent practice which is coming much into vogue, and which is especially useful where interchangeability is insisted upon. Another point worthy of notice is that the field coils, where possible, are provided with screw terminals for connection. There are no wires sticking out and liable to come off. The flat strip for series winding is, as a rule, wound on edge. For the smaller sizes of machines the company has designed special sliding bed-plates. These beds are held down by four bolts, and are provided with runners and a screw fixed in a slot and capable of entering a lug on the underside of the machine placed on the bed-plate.

The design in the cases of many of the machines which we saw struck us as being good, and, with the tools and appliances at its command, there is every reason why this company should turn out good work.

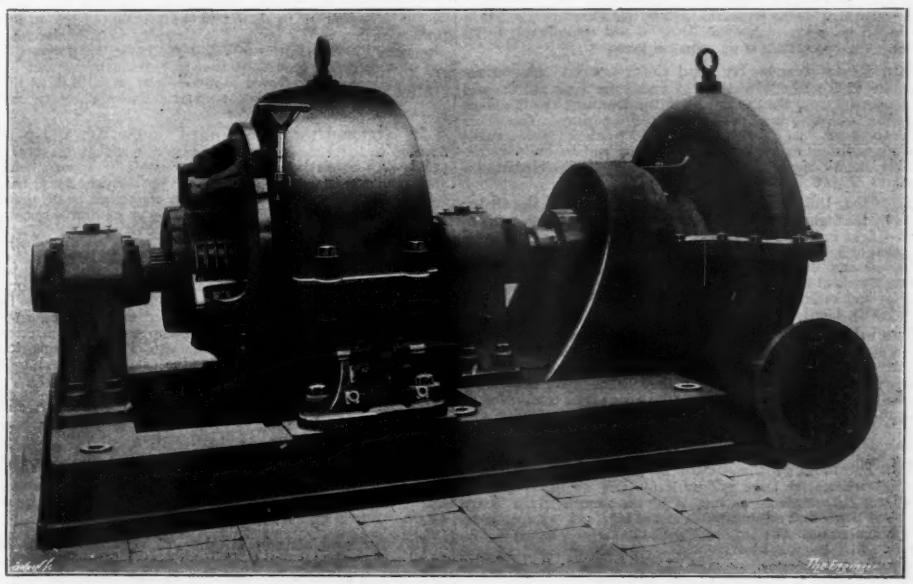


Fig. 8—MOTOR-DRIVEN CENTRIFUGAL PUMP

AN EFFICIENT DREDGER.—The Fruhling system hopper dredger Thames, which has been built for the British Dredging Company, Limited, when operating during her trials in heavy mud, is reported to have raised the material, in a solid condition, at the rate of over 3500 tons per hour. This is claimed to be more than five times as fast as the same material could be lifted by an ordinary bucket dredger. The Thames is about to leave the builders' yard and proceed to the Manchester Ship Canal, where she is to carry out some dredging operations for the Manchester Ship Canal Company.

RAILWAY MATTERS.

It is stated that cast-iron cylinder piers are to be used in the larger bridges of the new lines in Burma.

Experiments are being made upon the North-Western Railway of India for the introduction of electric punkahs and lights in the carriages.

The General Council of Lot-et-Garonne has passed a vote in favour of a railway penetrating into Spain by Luchon, Venasque, and Mouzon.

The directors of the Metropolitan Railway Company have recently been carrying out a series of trials of new electric trains on the Neasden section of their newly electrified section.

We understand that Mr. Marsh, of the Great Northern, has been appointed chief mechanical engineer of the London, Brighton and South Coast Railway in succession to the late Mr. Billinton.

The Central London Railway from 8.10 till 9.45 a.m., and again from 4.40 to 7.6 p.m., has a two minutes' service of trains. Although the New York Elevated Railway has a circular track, it only attains the same limit.

It is stated that the Union Pacific Railroad Company will soon have in operation several gasoline motor cars between Omaha and local stations on its Nebraska line. The cars will be built in the shops in Omaha as quickly as possible.

The first section of the new electric tramways at Exeter will be completed by the first week in December. By the time various preliminaries have been gone through, however, the sections will not be open for traffic until the New Year.

The electric tramway from Royton and Crompton was opened recently. It couples up the tramways of Oldham and Rochdale. The 6½ miles of single track, with twenty-three junctions, loops and cross-overs, and 30,000 yards of new granite paving, have been laid in the short time of fourteen weeks.

Recently the new electric locomotive belonging to the North-Eastern Railway made a series of trial trips from the Quayside to the South Trafalgar goods station, Newcastle, and the experimental runs proved that the current could be equally well collected from the overhead wires as from the live rail.

It is proposed to construct a new light railway through part of the West Riding of Yorkshire and North Lincolnshire, commencing at Ackworth, near Pontefract, and ending at the proposed new dock at Immingham, a total length of 49¼ miles. The survey has already been completed, and the necessary plans made.

It is rumoured that Liverpool is being mapped out by two of the trunk railway companies with the object of combined collection of goods and parcels and of concerted action in the running of passenger trains on rival lines. The London and North-Western and the Lancashire and Yorkshire Railway Companies are the two lines concerned.

The opening of Axholme Railway, from Crowle to Haxey, in Lincolnshire, took place on the 14th inst. The first consignment was 216 bags of potatoes for conveyance to Mexborough, in Yorkshire. Other consignments consisted of hay, corn, carrots, and coal. It is expected that the line will be open for passenger traffic in a few weeks.

Plans are being considered for the New York avenue bridge, which will be 500ft. long, carrying that avenue over the proposed series of tracks in the Eckington yards. In connection with the proposed changes in the T street bridge, which will be about 650ft. long, it is said that the railroad company wishes to build a bridge 24ft. wide instead of 30ft.

The London County Council has decided on the construction of about six furlongs of electric tramways on the conduit system in Rosebery-avenue, Finsbury. The cost of the roadwork, including plate-laying and paving works, but not including any portion of the electrical equipment, is estimated at £22,500. This amount does not cover the cost of the rails required for the work, estimated at £3500.

A peculiar locomotive which was built in the year 1874 is at present at work at the Coed Talon Colliery, North Wales. The frame and wheels are the remains of an old coal wagon, and upon this frame has been fixed an old portable engine, the motion of the main shaft being communicated by cog wheels to the axle of the wagon, geared in such a manner as to add considerably to its power. The speed limit is six miles per hour.

The Pennsylvania Railroad Company has placed an order for 6200 cars, 6000 distributed among the American Car and Foundry Company, the Pressed Steel Car Company, the Standard Steel Car Company, and the Cambria Steel Company. The other 200 ordered are steel coke cars, and with 600 ordered several weeks ago, are additions to the equipment. They will be built by the Cambria Steel Company. The value of the 6200 cars ordered is about £1,120,000.

The Board of Trade have recently confirmed the Order made by the Light Railway Commissioners:—London United Tramways—Light Railway Extensions—Order, 1904, authorising the construction of light railways in the County of Middlesex, between Hounslow and Cranford, and between Heston-Hounslow, Hanworth, Twickenham, and Sunbury Cross, being extensions of the existing and authorised undertaking of the London United Tramways (1901), Limited.

The inhabitants of Mitcham are disappointed at the action of the Board of Trade in granting a twelve months' extension of time for the construction of the light railway in their district, and at a recent meeting they called upon the Parish Council and the Rural District Council to convene a conference of local authorities with a view to arranging public ownership and control of the light railway, in order that there might not be any further delay in the construction of the line.

The President of the Board of Trade states that new "tube" schemes or large railway extensions for the metropolis must still be considered as subject to the warning given in the House of Lords that no enterprises of the kind can be considered by Parliament until the London Traffic Commission has issued its report. The President intimates, however, that exception might be made in urgent cases, and it is, of course, open to promoters to make application to Parliament in the usual way.

We understand that the Midland Railway Company has opened a new re-labelling station at Toton, South Derbyshire. The London and North-Western Railway Company has also established similar sidings at Welham Junction, near Market Harborough, which will enable coal from the North Derbyshire and district collieries to be re-labelled from the company's system to the Great Western line. The London and North-Western Company also contemplates affording traders additional accommodation of this character at other points.

Two methods of deadening the noises on the elevated roads in Chicago are said to have been presented to the sub-committee of the local transportation committee. One suggestion proposed encasing the existing structure in concrete. The present ties would be removed and the rails supported on beams of creosoted wood, laid longitudinally on a bed of sand or some other cushion. This in turn would be laid in a trough formed by cement walls resting on the top of the structure. Cement cross-ties would be used to bind the structure together.

NOTES AND MEMORANDA.

The gold-mining industry in Lapland has been closed, owing to the bad results obtained.

The Corporation of Dover propose to supply electric light and power to about a dozen villages near, and to extend their electric tramway system another two miles.

If experiments now being made with the concrete superstructure for the piers along the Government ship canal at Sault Ste. Marie prove satisfactory, it is probable that in the future the piers will be made of concrete above the water-line as fast as repairs are made.

Arrangements have been completed at Barrow for an extension of the already large petroleum storage to include new tanks for petrol and naphtha, and when this has been completed, it is said that Barrow will become the most important port in the country for this trade.

A consular despatch from Callao, Peru, reports that there is a very large coal area in the Department of Ancachs. It is situated about 66 miles from the port Chimbote. In the Santa Valley coal exists in immense quantities; in fact, it is said that it can be traced for 20 miles.

The Brooklyn navy yard and the Mare Island navy yard have each been given orders to build a collier authorised by Congress at its last session. These colliers will be the largest and fastest in the world, and 1,250,000 dols., say, £250,000, was appropriated for the construction of each.

It is stated that M. Pelletan has signed an order to begin building ten defensive submarines of a new type. Six of the small boats, which will not weigh more than 44 tons, will be constructed at Cherbourg and four at Rochefort. They will be known as the Wasps, and will be numbered from one to ten.

A simple and efficient polarity indicator may be made from white blotting paper saturated with a solution of potassium iodide. When a test is to be made the paper is moistened and the leads pressed down upon it about a ½in. apart. The positive end will turn brown, while the negative will not be affected.

An interesting plant has recently been laid down in Northern Italy. The works are situated near Grono, amongst the Alps, and energy is transmitted some 20 miles to Nombro at 40,000 volts. The reason for this very high voltage was that the engineers wished to get the loss of energy in the line down to 4 or 5 per cent., and to use wires not more than 6·5 mm. in diameter.

Another stride has been made in the application of wireless telegraphy in America. During seventy-five minutes five messages were received at New York with ease and accuracy from the De Forest Tower at the St. Louis World's Fair. The messages were sent from altitudes varying from 800ft. to 1500ft. The apparatus was hung below the main basket, which was found to be unfitted for sending the messages.

The United States Bureau of Naval Construction has made an exhaustive inquiry into the expense of building warships in Government yards, as compared with the cost of putting out such contracts to private companies, and in the report decides in favour of the latter. This is due to the fact that Government workmen are paid higher rates. The report advises the placing of future orders with private companies.

Wheels with deep rims should never be joined by internal flanges and bolts; centrifugal force tends to open the joint and bring a leverage to bear upon the bolts, which may be as much as four to one, compared with the same bolts in direct tension. In the case of thin-rimmed wheels, as rope or belt pulleys, for example, where internal flanges are almost a necessity, this leverage is not nearly so pronounced, but still it exists, and should be taken into account.

The Portland cement industry is making rapid strides in Canada, and the time is approaching when the requirement of that country will be supplied entirely by domestic manufacturers. The chief centre of the industry is in Ontario, which made 695,260 bbls. in 1903, as compared with 31,924 bbls. ten years ago. There were nine plants in operation, and four under construction. The new plants are being erected at Belleville, Raven Lake, Wiarton, and Brantford.

Experiments which have been carried out on the weight of crowds go to show that the loading of 82 lb. to 102 lb. per square foot usually assumed in Germany in floor design, and prescribed by the Ministry of Public Works for this purpose, is far too low to allow for conditions that may frequently occur. It is urged that this figure should be raised to at least 123 lb. to 133 lb. per square foot, otherwise the assumed factor of safety may be encroached upon materially.

It is stated that the United States Admiralty have decided to build three "scouts" with a speed of 25 knots and armed with three-pounders. These vessels, it appears, will be very similar to those already built for the British Navy, though full details are lacking. This decision shows, at least, that the utility of a "scout" class is recognised by an enterprising nation; but it was none the less rash of the Admiralty to have ordered so many as eight ships of an untried type.

The telephone tunnels in Chicago are being used for a decidedly novel purpose. A large office building is in course of construction, and a considerable quantity of earth is being excavated for its foundations. In order to avoid the troubles which attend the use of ordinary dump carts on such crowded streets, a shaft has been sunk at the site of the building to the tunnel mentioned, and through this the earth is lowered to cars running on tracks through the tunnel to the lake front.

The Customs return of iron and steel exports from the North of England during October are disappointing as regards pig iron, as there is a drop of 34,000 tons on last year, but manufactured iron and steel shipments are satisfactory. The totals were:—Pig iron, 75,945; manufactured, 14,070; steel, 28,481 tons. Of railway material and bridge work despatched, 14,000 tons went to India, 5000 to West Australia, 3000 to Cape Colony, and 2000 to Egypt. Russia took 700 and Japan 1100 tons of pig iron.

Platinum of atomic weight 195, specific gravity 21·5, fusing point 1750 deg. Cent., the most malleable metal known next to gold and silver, resists oxidation at high temperature, and is unaffected by acids. The world's production ranges annually between 160,000 and 170,000 troy ounces, supplied chiefly from Russia, and Colombia, South America. Owing to the war in the Far East the price has advanced so much for ingot platinum at New York that it is now nearly the valuation of gold, and about 34 times that of silver.

For more than twenty years, says the *Journal de St. Pétersbourg* in a recent issue, researches have been made with a view to fixing on a waterfall capable of furnishing sufficient power to supply St. Petersburg with electricity. Hitherto, the most suitable for this purpose appeared to be a cataract in Finland, which it was proposed to utilise for the working of an electric tramway. Further researches, however, have resulted in the discovery of the Kiviniemi Waterfall, on the river Voksen, forty-six miles from St. Petersburg, with energy equivalent to 25,000 horse-power. This waterfall is about forty-five miles closer to the metropolis than that in Finland, and is offered for sale at a considerably smaller price. Unless the difficulties of conveying the current prove insuperable, the Kiviniemi Waterfall will be purchased.

MISCELLANEA.

During the past month orders for twenty-one new large ships have been placed with the yards on the Great Lakes in the United States.

The Canadian Association of Steam Engineers intend to petition the Ontario Legislature to pass an Act requiring every man in charge of a steam engine of over 25 horse-power to have an engineer's certificate.

It has been decided to build at St. Petersburg next year a new model yard for naval construction. The plan has been already drawn up, and the work of carrying it out will cost the State one million roubles.

We learn that Sir Charles Hartley and Sir John Wolfe Barry, consulting engineers to the Natal Government, have resigned their posts in consequence of the Government having disregarded their plans for harbour development.

The Secretary of the United States Navy intends to ask Congress for an increased force of naval officers and sailors, as 2087 officers and 62,368 men will be required to man the ships building or built, or over twice the number at present sanctioned.

The Right Hon. Lord Reay will present the prizes at the Northampton Institute for the session of 1903-4, on Friday, 9th December, at eight o'clock. The prize delivery will be followed by a conversazione, which will be continued on Saturday, 10th December.

The French Ministry of Marine have decided to organise an official race for motor boats from Calais to Dover, to take place next spring. The object of the race is understood to be the deciding of the best class of motor boat for use in connection with the French navy.

Last Saturday the Lebaudy airship made its twentieth ascent this year. Leaving Moisons at 4.27 in the afternoon it made for Freneuse and Bonnieres. On returning it performed several evolutions, and was brought back to the shed at 4.55. The maximum altitude was 110 metres.

The question of an improved system of water supply for shipping purposes at North Blyth is not yet definitely settled. It is proposed to lay mains along the North-Eastern Railway Company's staiths at the north side of the river, and in this way supply ships much quicker than can be done at present by the water boats.

The Simla Waterworks Committee have rejected General Beresford-Lovett's scheme for obtaining water from the Sutlej, and recommends instead another arrangement—a hydro-electric scheme—whereby the electric power for both pumping and for lighting the station is to be obtained by the erection of turbines in the Nautikhud Gorge.

It is announced that after the 19th inst. our warships will come home every two years instead of three, and the time officers have to spend abroad will consequently be reduced by one-third. Ships will come home more frequently and be always kept in good fighting condition, no repair work being allowed to accumulate, as it sometimes does at present.

The Admiralty have issued orders for the entry of a large number of lady tracers in Devonport Dockyard. It is understood there are vacancies in all the departments in both the north and south yards. The ladies will be employed under the Factory Acts, will commence work at nine o'clock in the morning, and leave off at the same time in the evening as the Dockyard workmen.

Captain T. S. Baldwin's airship, says the *Scientific American*, flew through the air at St. Louis October 25th, in the face of a ten-mile breeze, at the height of half a mile for a distance of about ten miles. Several accidents occurred during the trip, the more serious of which was the breaking of a chain, which caused the operator to open the gas valve, bringing the craft to the ground.

The Institution of Civil Engineers of Ireland, as a result of the success of the experimental excursion to Belfast in June last, hope to organise a similar meeting next year. It was indicated by the President at a council meeting that the place selected might be Rosslare and Fishguard, where harbour works are in progress connected with a new cross-Channel service to the south of England.

Water wheels are fairly common in China, but windmills are practically unknown, though China is by no means a windless country, such as Burmah is in many parts. Simple wind motors, costing little and easy to erect, could well be used for many purposes where cheap power is required, especially for pumping and general irrigation work, and once introduced their simplicity and comparative cheapness would appeal to the native mind.

A committee have reported to St. Austell Rural District Council that a harbour of refuge was absolutely necessary, and should be situate at some point between St. Ives and Padstow, to accommodate all classes of shipping, irrespective of size. On the question of expenditure they could form no opinion. It was agreed to forward the report to the joint committee of the Cornwall and Devon County Councils, who are considering the subject.

In the consular report for Greece it is stated that there is no accurate survey of the country. The work necessary to obtain this is being carried out under the direction of the Ministry of War. It appears to be proceeding somewhat slowly, as it is estimated by the department that thirty years will be required to complete it at the present rate of progress. A first triangulation of the whole of Greece has been completed, a second of the greater part of continental Greece, a third and fourth of the greater part of Thessaly.

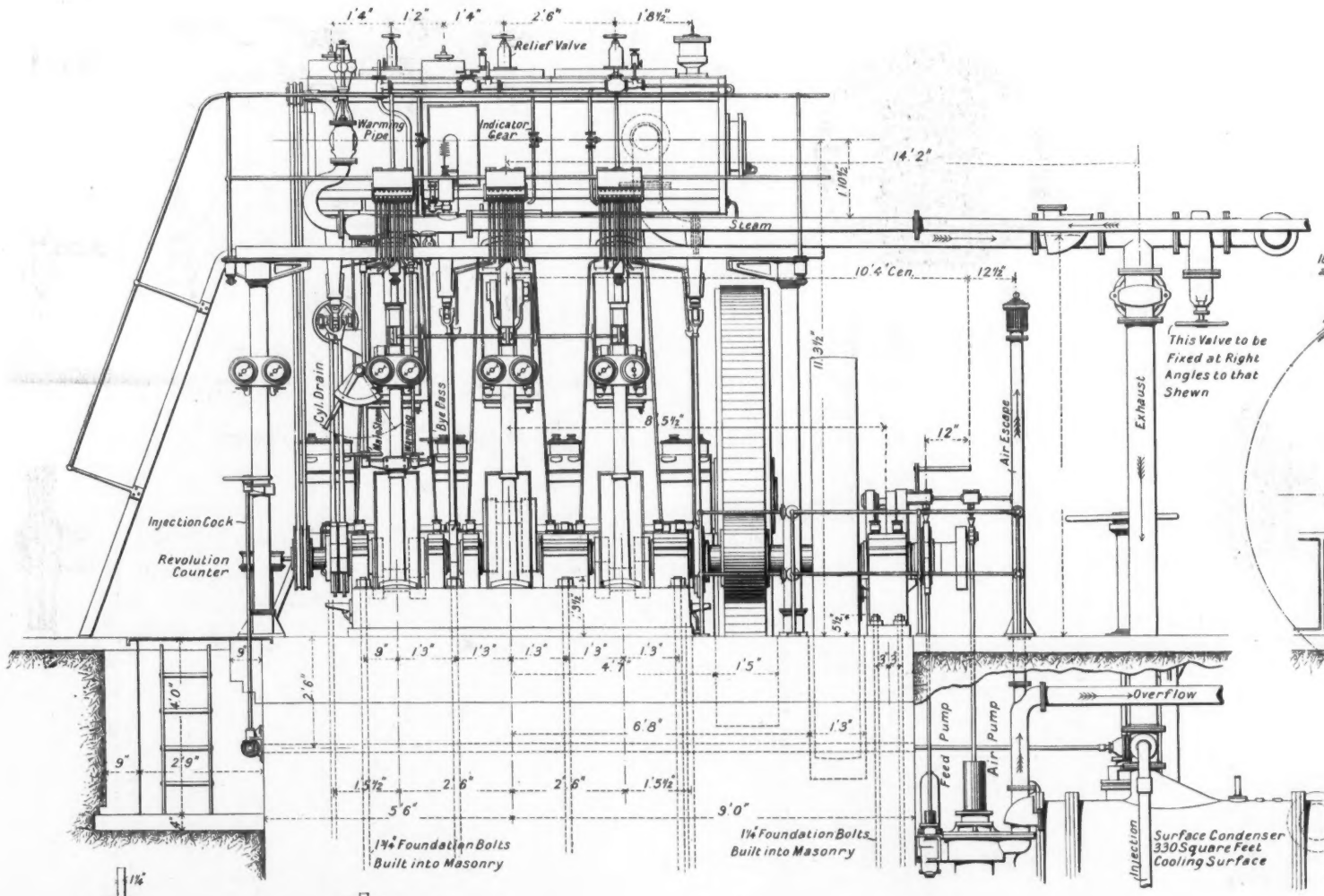
At its sitting last Monday, the 14th, the Canal Committee of the Lower House of the Prussian Diet passed the first reading of the Bills providing for the construction of the Dortmund-Rhine Canal, the canalisation of the Lippe from its mouth to Hamm, the construction of supplementary works on the Dortmund-Ems Canal, the construction of a canal from Bevergen on the Dortmund-Ems Canal, a ship canal on the Weser at Hemelingen, and to bear a third of the cost of the building of the dams on the tributaries of the Upper Weser.

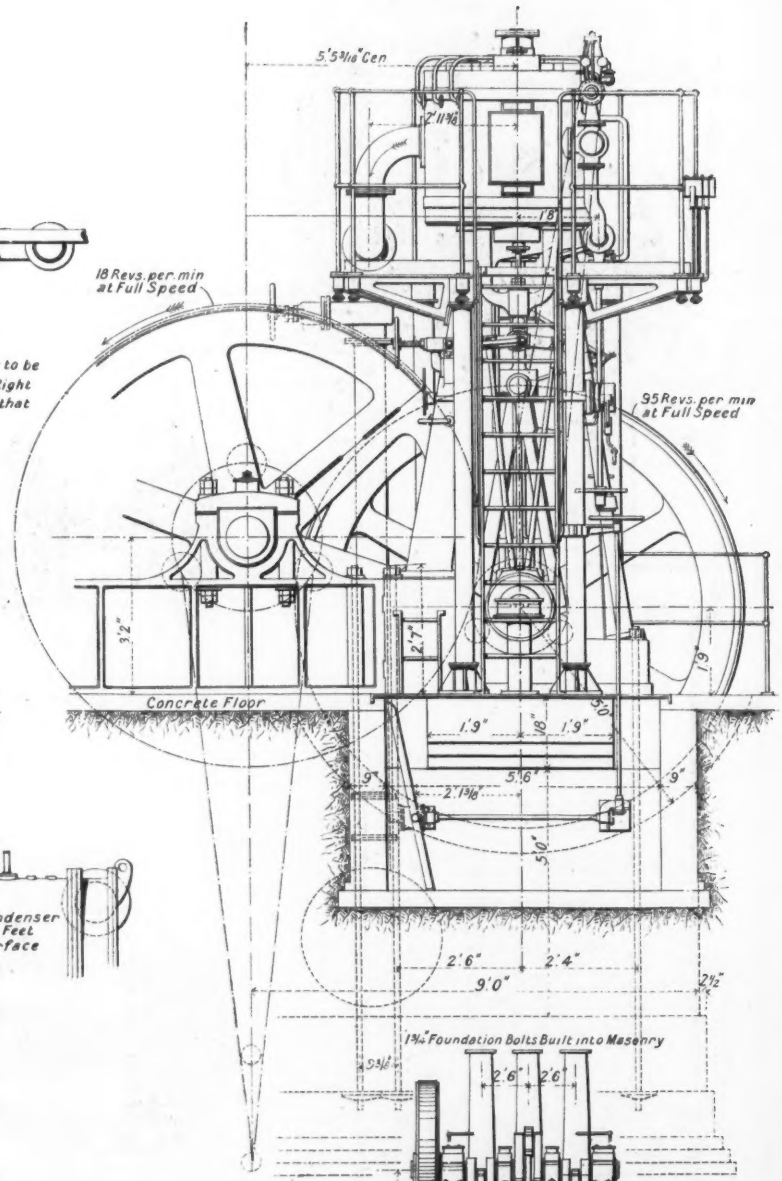
The war between stone, brick, and concrete is going on apace in America, and the stone men of Topeka, Kansas, have united with the brick manufacturers in opposing the use of cement blocks as building construction in that city. A petition has been filed by the cement building stone manufacturers for a revision of the building laws, in order that concrete cement blocks and brick may be admitted. A hearing has been ordered, and a number of tests are now being made to see whether the cement blocks are fireproof, and also whether they should be permitted to be used in construction.

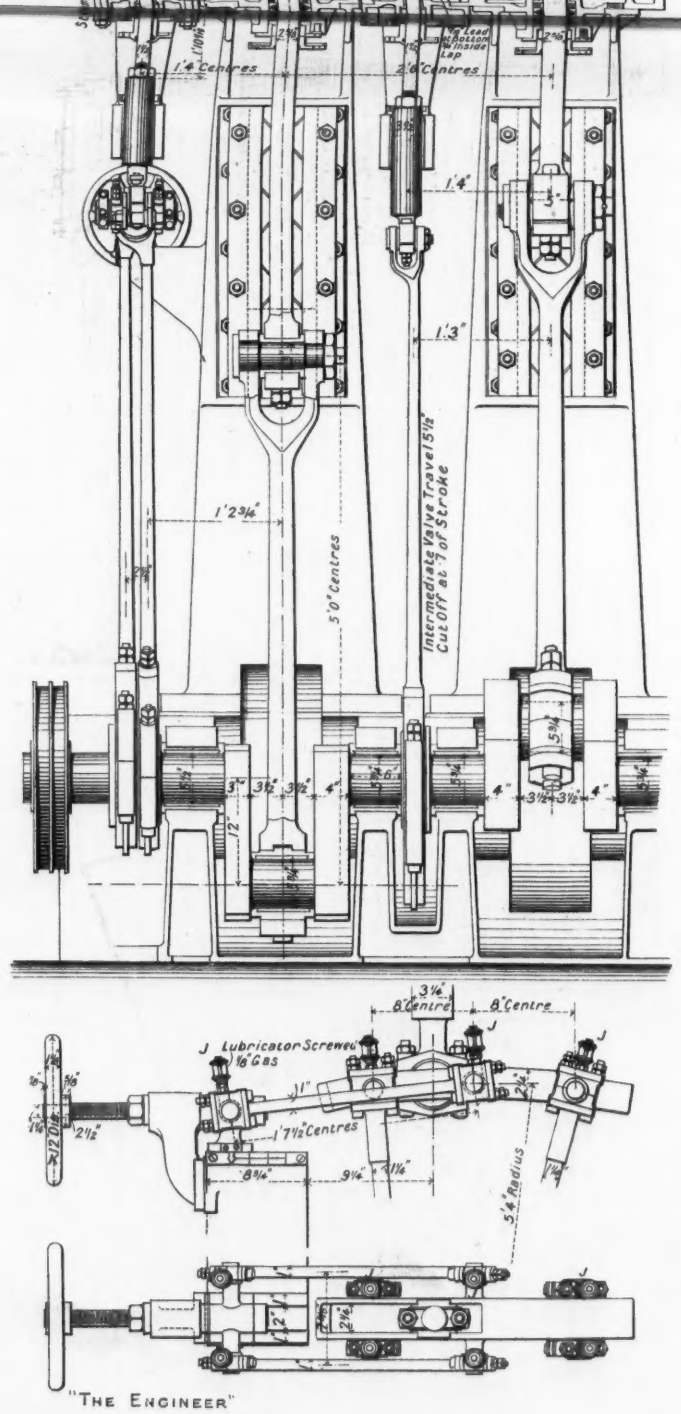
The Island of Ouessant was chosen by the French Minister of Marine for the first wireless telegraph station, recently opened to the public, because it is that portion of France which extends furthest into the Atlantic on the route of vessels entering or leaving the Channel. It is at the highest point, called the Stiff, where the station is established, and the instruments have at present a range of 150 kiloms. = 93 miles, which, it is expected, will be increased. The *Matin*, which gives these particulars, believes that a second radiotelegraphic station will shortly be opened to the public on the Mediterranean.

HIGH DUTY PUMPING PLANT, CHATHAM DOCKYARD

MESSRS. HAYWARD-TYLER AND CO., LIMITED, LONDON, ENGINEERS







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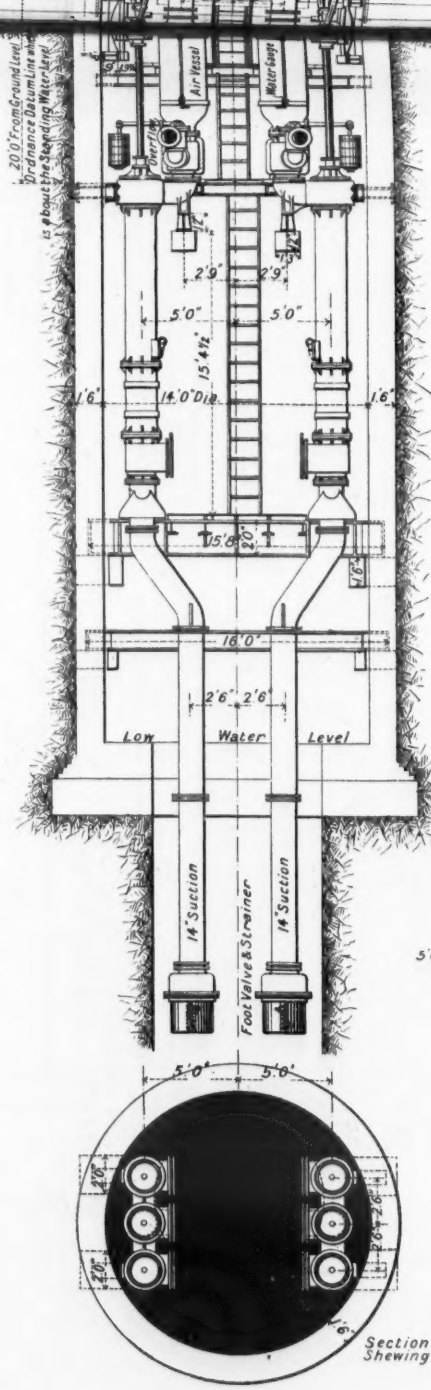

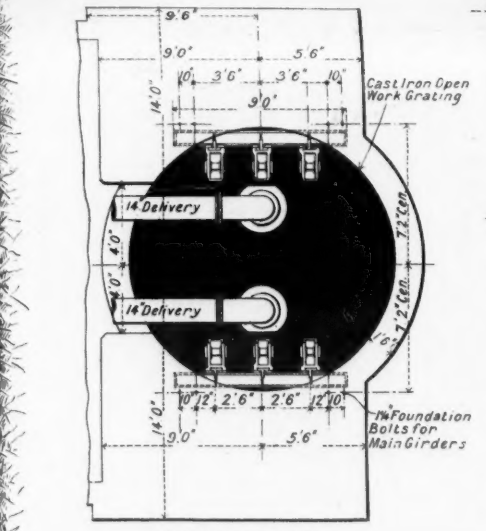

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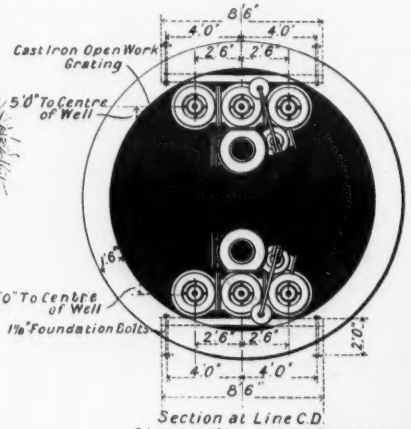

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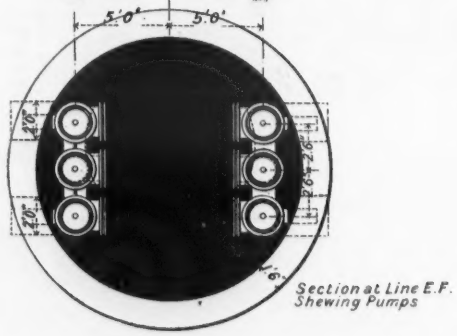

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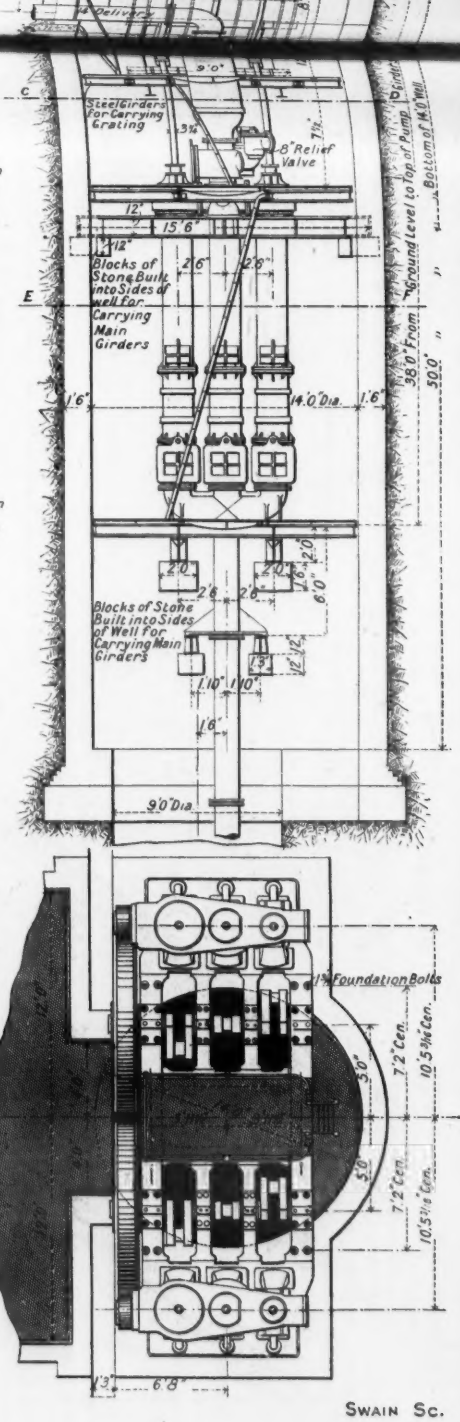
Shewing Pumps



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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Ten o'clock on Tuesday morning in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of The Engineer.

Telegraphic Address, "ENGINEER NEWSPAPER, LONDON." Telephone—No. 13352 Central.

PUBLISHER'S NOTICES.

*** *With this week's number is issued as a Supplement, a Two-page Drawing of the Pumping Installation, Chatham Dockyard. Every copy as issued by the Publisher includes a copy of the Supplement, and subscribers are requested to notify the fact should they not receive it.*

*** *If any subscriber abroad should receive* The Engineer *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* The Engineer, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

Aqua.—Nevill's hydraulic tables are all but universally accepted. You will find in his book a complete disquisition on the subject.

G. K.—We very much doubt if all the information you require has appeared in any one journal. Why not apply to the Water Board, Savoy-buildings, Strand?

Suffolk.—You might try "The Motor Manual," by the publishers of the *Motor*, price 1s; "Motor Cars and the Application of Mechanical Power to Road Vehicles," by Rhys Jenkins, M. Inst. Mech. E.; London: Fisher Unwin; "Modern Engines and Power Generators," by Rankin Kennedy," vol. iii.; London: The Caxton Publishing Company,

Mac (Glasgow).—The work done by each stroke of the piston is complete in itself, and nothing would be gained in the way you seem to think possible. The only advantage conferred by a condenser is that it removes back pressure to the extent of 10 lb. or 12 lb. per square inch, and so more power is got out of the engine for the same consumption of coal. Unless your engine is now overloaded you will not gain any advantage by altering its speed. Whether it is overloaded or not we will tell you if you will send us a set of indicator diagrams.

INQUIRIES.

NICKEL STEEL TUBING.

Sir,—I should be much obliged if any of your readers could inform me where I could obtain nickel steel tubing ⅜in. diameter with a ¼in. bore.
November 16th. J. B. D.

ERRATUM.

In our issue of November 4th, on page 452, in line 10 of the article on the Powell Wood-preserving Process, for the word "porosity," read "non-porosity."

MEETINGS NEXT WEEK.

Society of Arts.—Wednesday, November 23rd, at 8 p.m. Ordinary meeting. Paper, "The Systematic Promotion of British Trade," by Ben. H. Morgan.

Permanent Way Institution.—Saturday, November 19th, at 2.50 p.m. Visit to view the Midland Railway Company's Locomotive and Carriage Works at Wigston.

The Institution of Civil Engineers.—Tuesday, November 22nd, at 8 p.m. Ordinary meeting. Paper, "Distribution of Electrical Energy," by John Francis Cleverton Snell, M. Inst. C.E.

Institution of Electrical Engineers: Birmingham Local Section.—Wednesday, November 23rd, at 7.30 p.m., in the Physics Theatre of the University, Edmund-street. Address by Dr. W. E. Sumpner, M.I.E.E.

The Junior Institution of Engineers.—Monday, November 21st, at 9.20 a.m. from Euston. Visit to Dudley Port and Birmingham to inspect the Central Station of the South Staffordshire Mond Gas Company and the Nechells Gasworks of the Birmingham Corporation.

The Royal Sanitary Institute.—Saturday, November 26th, at 11 a.m., at the Council Chamber, Exchange-buildings, Nottingham. Discussion, "Some Present-day Aspects of Conservancy Systems," by Philip Boobbyer, M.D., M.S., M.R.C.S., Medical Officer of Health, Nottingham.

The Faraday Society.—Wednesday, November 23rd, at 8 p.m., in the Library of the Institution of Electrical Engineers, 92, Victoria-street, S.W. Papers: "Recent Investigations Bearing on the Theory of Electrolytic Dissociation," by Professor L. Kahlenberg, Ph.D. "The Potential of the Hydrogen-oxygen Cell," by F. J. Brislee, M.Sc.

THE ENGINEER.

NOVEMBER 18, 1904.

DRY AIR IN THE BLAST FURNACE.

We commend to those of our readers who are interested in the manufacture of pig iron the paper read by Mr. James Gayley at the New York meeting of the Iron and Steel Institute. An abstract of the paper, which omits nothing essential, will be found elsewhere in our pages. Mr. Gayley deserves credit for an original research carried out at considerable expense, and with eminently satisfactory results. He has arrived at certain conclusions which we hold to be wrong. About the facts we have no doubt. We take exception to the hypothesis which he has framed to account for the facts. The questions raised are extremely attractive both from a chemical and a thermal point of view, and we trust that they will be discussed by chemists and metallurgists very fully and very fairly.

We can narrow the issues by confining our attention to a few facts taken at haphazard from many. Mr. Gayley has arrived at the conclusion for reasons set forth in his paper, that a considerable advantage would be gained if blast furnaces were supplied with dry air instead of with air containing moisture. It is a familiar truth that cold air will carry less moisture than hot air. Availing himself of the fact, Mr. Gayley constructed a large cooling chamber, fitted with multitudinous pipes, through which brine far below the freezing point flowed. The air on the suction side of the blowing cylinders passed through this chamber, was cooled down, deposited its suspended moisture, and entered the blast engines well desiccated. The result, as set forth, was that while with normal blast the output of the experimental furnace was 358 American tons per day, and a coke consumption of 2147 lb. per ton, with dry blast the output became 447 tons, and the coke 1726 lb. per ton. Thus we have a saving of 421 lb. of coke per ton of pig. The precise figures given by Mr. Gayley show that during a period of thirteen days the average moisture in the atmosphere was 5·66 grains per cubic foot, and in the dried air 1·75 grains. Sixty-nine pounds of water were removed from the blast per ton of iron produced, which represents an average of 23,192 lb., equivalent to 2784 gallons, for the twenty-four hours. This weight was calculated from the volume of air blown into the furnace, as shown by piston displacement. For four days during the above-named period the water caught in the tank underneath the refrigerating chamber amounted to an average of 21,561 lb. equivalent to 2588 gallons, for the twenty-four hours, which is in very close agreement with the other figures.

With these data before us we are in a position to consider what actually took place. The first fact is that under no circumstances can water enter a blast furnace unless a tuyere is leaking. All the 69 lb. of water per ton of iron made was converted into superheated steam in the heating stove. It is a weak point in Mr. Gayley's paper that he only incidentally mentions the temperature of the blast, which, he says, was not much more than 800 deg. Fah., and could not be more because of the defective construction of the stoves. The temperature of the blast with dry air and moist air are important factors. We are left to believe that the drying of the air made no difference. So far, then, we have injected into the furnace 69 lb. of superheated steam with a temperature of at least 800 deg. Fah. per ton of iron. At the blast pressure each pound of saturated steam would have a volume of about 20 cubic feet. We do not pretend to know what the volume would become when superheated, because there is very little settled by direct experiment; but if we assume that the volume was trebled, we have $60 \times 69 = 4140$ cubic feet of steam per ton, a volume quite insignificant as compared with the 40,000 cubic feet of air per minute sent through the tuyeres. Taking the figures in another way, about 21,000 lb. of steam went into the furnace, while 1,001,280 lb. of iron were made. To convert 21,000 lb. of water into steam would require about 2100 lb. of coke per twenty-four hours. The actual saving effected was, however, 188,189 lb. of coke per twenty-four hours, which is quite out of all proportion to the saving effected by removing water; and, furthermore, it must be remembered that the coke in the blast furnace did not evaporate the water; that was done in the stove by waste gas. Again, the quantity of water going in in the air is as nothing to that contained in the ore. We may therefore reject, once and for all, the theory that the saving effected was secured by avoiding the loss of heat expended in converting suspended moisture in the air into steam. To the chemist we must leave the consideration of the effect on the working of a blast furnace of the injection of a comparatively small volume of superheated steam. Possibly dissociation would take place not far from the tuyeres; but this would not represent loss, for further up in the furnace the hydrogen liberated would, no doubt, combine again with the oxygen, and give back all the heat energy expended in bringing about dissociation.

It is not necessary, however, to cast about for recondite chemical or thermodynamical explanations of how or why economy was secured. The saving was, we hold, the result not of using dry air, but of using cold air. The chilling of the air augmented its density, and virtually increased the delivery of the blast engines, while the pressure, and, consequently, the work done, remained unaltered.

Mr. Gayley gives a table of temperatures but not volumes. We may supply the deficiency for a few taken at hazard. The inlet or suction temperature being 70 deg. Fah., the volume per pound is 13·342 cubic feet, the chilled temperature from the cooling chamber to the blowing tubs was 20 deg. Fah., and the volume 12·08 cubic feet; on another occasion the atmospheric temperature was 80 deg., the volume of one pound was 13·59 cubic feet. This was reduced in the refrigerating chamber to 22 deg. Fah. and 12·13 cubic feet. We have here a very ample augmentation in the weight of the air blown in, the blast pressure remaining unaltered, and we find accordingly that while "before applying the dry blast the engines were running at 114 revolutions and supplying 40,000 cubic feet per minute, the revolutions were gradually reduced to 96, thereby reducing the volume of blast over 6000 cubic feet per minute, and increasing the efficiency of the engines by 14 per cent. With dried blast 96 revolutions per minute of the blowing-engines burned nearly 1 per cent. more coke and produced 89 tons more pig iron in twenty-four hours than 114 revolutions on natural air. The reduction in the revolutions resulted in a gain of 150 deg. in temperature of the blast, which even with this increase, through lack of area in the waste gas ports of the stove, did

not average above 870 deg." As we have just seen, the reduction in volume reached as much as 12 per cent., which fairly enough approximates to the 14 per cent. given by Mr. Gayley.

The blast furnace is a remarkably delicate chemical apparatus, and the facts before us open up a field for inquiry that has scarcely yet been touched. It is well known to most iron makers that the weather has a very considerable effect in modifying the output and quality of the iron. We can call to mind a furnace in Staffordshire which obstinately refused to make anything but white iron when the wind blew from a certain quarter. We venture to think that we have shown that no reason whatever can be assigned for the improved working of Mr. Gayley's furnace on the ground that the air was dried. On the other hand, things become pretty clear as soon as we remember that the density of the air was augmented some 10 or 12 per cent. by the cooling. Even then, however, something remains to be explained. We gather that the experimental furnace had not been working with sufficient blast; consequently it could not carry an adequate burthen even by driving the engines hard. Cooling the air had the same effect as augmenting the output of the blast engines. Whether, however, the increased density of the blast and the absence of a small quantity of superheated steam played any special part in the internal economy of the furnace is a matter which deserves careful inquiry. We trust that Mr. Gayley will be able to put ironmakers under more obligations when he has pushed his researches somewhat further.

THE USE OF ELECTRICITY IN FACTORIES.

In our issue of the 21st October we gave in full the text of the new regulations which the Home-office proposes to institute regarding the use of electricity in factories. These regulations were widely circulated in draft, and were accompanied by a notice setting out that any objection of substance, made by employers, workpeople, or other persons affected, would be carefully considered by the Secretary of State, and would, if necessary, be the subject of full inquiry made by a competent person appointed by him. It was further stated that all persons concerned would be entitled to a full hearing at such inquiry, and that the report of the person holding the inquiry would be considered by the Secretary of State before the regulations were finally put into force. Any objections to the suggested regulations had to be lodged with the Secretary of State within forty days from the 15th of ast month. It is not our purpose to detail in the present instance the whole of the innovations. Those interested have before now doubtless mastered them. Our aim is rather to consider what, if any, objections are likely to be made to the intended action of the Home-office, and whether or not such objections are valid.

There is reason to believe that some of the new regulations are being viewed with small approval by users and manufacturers alike. Perhaps it may be well to give a few examples. The first regulation states that "All wires in connection with the supply shall be enclosed in strong metal casing, and, where this is not practicable, they shall be so arranged that there shall not be any danger of shock or of fire." It is pointed out by some persons that it would be exceedingly difficult satisfactorily to draw the line between places where it was and was not practicable to use protection of this kind for the wires. It is, moreover, objected, and with a considerable amount of reason, that wires in metal cases are inaccessible and difficult to inspect; that it is not easy to localise faults in them and hard to maintain a good insulation resistance between conductors and earth, owing to the condensation of moisture. The encasing of electric wires in metal tubes for circuits in buildings was at one time enthusiastically received as being the universal panacea for all ills. If our memory serves us rightly, a system of this type received an award some nine or ten years ago from the Society of Arts. Experience has shown, however, that though good in some cases, this method cannot be employed universally. This is especially so in places where there is any tendency to dampness. Metallic casing, moreover, is expensive, and people are now-a-days not unnaturally desirous of spending as little on capital account as possible. To take its place it is suggested that cables supported on insulators spaced a suitable distance apart would afford all the required safety. They would, it is urged, have the advantage of being readily accessible, and a good insulation resistance could be maintained. Again, the new regulations demand the provision of a switch to every single arc lamp, even when these are connected in series and prevent the control of arc lamps in groups when the pressure exceeds 250 volts above earth. Now, in many instances lamps are run in series on 500 volt circuits, and the use of 500 volts is likely to become more and more general as time goes on. Hence, it would not appear to be out of the way to request re-consideration of this clause so that such a voltage might be included. The case might, perhaps, be met by an alteration to the effect that where the pressure cannot exceed, say, 600 or 650 volts, it would be sufficient if one properly designed double-pole switch, conveniently placed, were provided for each series of arc lamps. On the other hand, it must not be lost sight of that whereas it is undoubtedly convenient to have several lamps in series, yet saving can frequently be effected by the ability to switch out lamps not actually giving useful light. So that there are those who will not, if they can help it, use these high voltages and numbers of lamps in groups except when they are in series on a constant current. One more example will suffice with the foregoing to give some idea of the trend of the regulations. It is proposed to insist that all metal holders for incandescent lamps, the frames of all motors, and the metal casings of all wires, switches, fuses, and cut-outs, should be efficiently connected with earth. As far as we can see, exception is only taken with regard to the incandescent lamps. In this connection it is urged by some that the increase in cost resulting from the enforcement of this provision would render the electric lighting of factories prohibitive. Moreover, the plain pendant fitting could not be employed.

Such, then, are some of the views taken by those whom the new rules will concern in one way or another. There is no reason to doubt that these and other objections will receive due consideration by the Home Secretary. No one will say that every reasonable precaution should not be taken to prevent accidents and possible loss of life. Yet, on the other hand, it must be remembered that the electrical industry in this country has from the outset been severely hampered by legislation. Just now there is a widespread and increasing movement to adopt this form of energy in factories and workshops for both lighting and power. It would be a thousand pities to do anything to stop this enterprise. The methods of wiring are not what they used to be. We do not now-a-days, for example, see plain gutta-percha wires led over and touching steam pipes or carried in a haphazard manner in marline slings—proceedings not unknown in the old days. Still, some sort of supervision is a necessity, and we have but little doubt that the new regulations as finally agreed will be acceptable to all parties concerned. Already we in this country have to be far more particular regarding electrical installations than are our near neighbours on the Continent. We do not recommend the adoption in their entirety of continental methods, but we do say that restrictions can be carried too far. For this to be so in the present instance would still further help to strangle an industry which appears to be making increasing headway after a very laborious commencement.

VALVES AND VALVE GEAR.

Recently much information concerning the latest types of "distribution" valves has been published in our columns. The word "distribution" is very convenient because it admits of wide application. Distribution valves are those which "distribute" the steam in an engine. In our pages have been described the system of distribution used in high-speed engines in this country, and in engines of all kinds exhibited at St. Louis. Practice differs very much. There are several conditions to be satisfied, and while some engine builders comply with one set, others comply with other conditions which they regard as the more important. It seems clear that we cannot have everything, and individual proclivities very largely determine what the valve gear of a steam engine shall be. One man purchases simplicity at a price, another saves coal by introducing complexity, and so on. But there is reason to believe that a change is gradually taking place in valve gear as in everything else mechanical. The slide valve and Corliss rotary valve are gradually being superseded by the piston valve and the drop valve, and rivalry may be regarded as existing between only these two. The rotating Corliss valve will, indeed, continue to be made, so will the ordinary slide valve; but neither can any longer be considered to represent the very best practice.

Confining our attention, then, to the piston and the drop valve, let us see what can be said for and against both. The only advantage possessed by the piston valve is that it requires less power to work it than does the slide valve. A bare statement of this kind, however, does not do justice to the situation. The saving in power is quite an anciliary matter. If a valve can be worked easily, the valve gear will enjoy a special immunity from the chance of breakdown and the certainty of wear and tear. When superheated steam is employed, slide valves are very liable to cut the working faces. It would be but painting the lily to expatiate on the benefits which are, at least in theory, conferred by the piston valve. On the other hand, there are serious obstacles in the way of its use. We need not stop to consider any of these but one. It is now clearly understood that, if an engine is to rank with the best, the percentage of clearance must be very small. Now, with the piston valve it is unfortunately very large, because in order to get sufficient port opening, the steam must be able to escape through orifices all round the barrel in which the piston valve works. Besides this, the piston valve must be very large in diameter, and we get a heavy and expensive engine. It would appear that, if the piston valve is to be used, it might be better to model it on the same pattern as the old "long D" slide, with a flat face, double ported if necessary, next the cylinder, and a curved back. Such valves have been used with very great success for years with low pressures, and there ought to be no insuperable difficulty in remodelling them to suit the high pressures of the present day. Be this as it may, the normal piston valve entails large cylinder clearance, and that being the case, engines fitted with it can never attain the maximum possible economy in the use of steam. It may perhaps be worth while here to say that some sixty years ago Seaward patented the application of four independent flat-plate slide valves to a cylinder, two for admission and two for exhaust. The clearance in this case was about as small as it is possible to make it with sliding valves of any kind; but we do not suppose that the inventor saw that any advantage was to be gained from this. Indeed, it is only within the last few years that the influence of clearance on the consumption of steam in an engine has come to be understood and appreciated. Rankine made a mistake, and what he said was taken without question as true, and clearance regarded as of little effect so long as there was enough compression.

Turning, now, to the drop valve, we find in it a system of distribution which has only one serious defect. We use the word "drop" here advisedly, to distinguish the valve which we have in mind from the double-beat or Cornish valve. That is a very beautiful mechanical device, but its use entails an amount of clearance nearly, if not quite, as great as that pertaining to the piston valve. The drop valve is a conical or a tubular valve, controlled by a dashpot, and its design and construction have been brought to such perfection that it works with absolute silence and entirely without jar or shock or clatter. Its great defect, to which we have referred above incidentally, is that engines fitted with it cannot be run comfortably at a speed of more than about 90 revolutions per minute. But even this defect is being got over, and the use of the lever lifter with an automatic travelling fulcrum—first, we think, brought prominently into public notice at the Düsseldorf Exhibition two years ago—is doing much in skilful hands to permit of speeds much greater than that we have named being attained. It is certain, however, that in many cases the most has not been made of the drop valve, and one purpose we have had in view in writing this article is to call attention to the superlative advantages which the drop valve confers on those who wish to build steam engines of maximum economy. As the drop valve is most usually fitted, we find a chamber constructed at each end of the cylinder in which the valve is placed, a port of some considerable cubic capacity being required to carry the steam into the cylinder. The arrangement is convenient, no doubt, in various ways; but it is very defective. To take full advantage of the drop valve it must be placed directly on the cylinder cover, and the smaller face of it should coincide when closed with the inside cover face. There will then be no clearance — provided the exhaust valve is made and fitted in the same way — save that between the piston and the cylinder cover; in other words, clearance will be the least possible. Those of our readers who are familiar with ammonia gas compressors for refrigerating plant will understand at once what we mean. The suction and delivery valves in the ammonia gas pumps are drop valves, the inner faces of which are flush with the cylinder cover when shut, the pistons all but touching them at the end of each stroke. That there is nothing impossible in what we suggest is demonstrated by the fact that steam engines have been made in this identical way in Germany and France, and given much satisfaction. There is another method of distribution which gives much the same result—we refer to the rotating plate valves on the cylinder cover at one time made by Sulzer, and introduced into this country, if we are not mistaken, by the late Bryan Donkin. We

have not seen any engine fitted with this gear for a long time.

In designing distributing valves the primary object of the engineer should be to get rid of waste spaces. In a word, to reduce clearance to the lowest possible point. But he cannot stop here. He has next to consider how a valve properly designed and properly placed is to be moved. Curiously enough, a great many patents have been taken out for improvements in valve gear, all intended to better the time function; and the same ground is gone over and over again. But the ordinary drawing-office chief takes little thought of this. In other words, improvements in the action, as apart from the construction of distributing gear, all appear to emanate from a very limited number of brains. No doubt the lesson is that the head draughtsman has, as a rule, to see first of all that his gear will work, and will go on working for years, and that it shall not cost too much, nor break down readily. After that come its merits as a distributing system. The steam-using world is pretty far yet from being supplied with the best possible valve gear; but there is no lack just now of people who are trying to do better, and so far as the stationary engine for mill or power-house is concerned, it is beyond question that the drop valve fitted on the cylinder cover direct promises the maximum possible economy in the consumption of steam—at least, in so far as any valve gear can affect that consumption.

ELECTRIC TRAMWAYS IN LONDON.

THE first electric tramway on the overhead trolley system in this country was established at Leeds exactly thirteen years ago, and it is therefore probable that London would have enjoyed the advantages of improved transport facilities on the tramways several years ago if it had not been for the determined opposition of the London County Council to the use of overhead wires, and the evident intention to squeeze private enterprise entirely out of existence in the metropolis. Overhead wires were held in absolute abhorrence by a majority of the members of the County Council, who decided that they should neither be introduced by tramway companies nor by the County Council themselves. The only concession ever made—and that, too, after negotiations extending over two years—was to allow the London United Tramways Company to adopt the trolley system on the three short terminal lines on the borders of the county in the west of London. All attempts made by this company to extend the system have been fruitless. All endeavours made by other companies in the south and south-west of London to obtain powers to construct trolley lines have been equally unsuccessful, owing to the refusing of the schemes by the County Council, even if the local authorities have regarded them with favour. The County Council has plainly indicated, if not in words at all events by its actions, that a tramway undertaking other than by itself shall not exist in London; and the Council finally came to the conclusion that of the surface contact system and the conduit method, the latter was the only one suitable for the requirements of the metropolis. This fact was emphasised by the purchase and installation at the Camberwell depôt of a short section of conduit tramway which had been on exhibition at the Agricultural Hall, and which on a memorable occasion was shown to metropolitan borough engineers and surveyors and borough councillors as being typical of what the London County Council intended to introduce on the tramways, but which was not adopted. The County Council selected a conduit system of its own, and once again the borough councillors and officials, in May of last year, had impressed upon them the advantages of the conduit system as then put down on the Westminster-Tooting tramways.

It will be seen from the attitude of the County Council in the past, and the impressions which it has sought to create in the minds of the twenty-nine borough councils in London, that the former have placed the conduit system before the latter as the ideal and only method applicable to the needs of the metropolis. If not, the County Council would never have agreed as ti did four years ago to the insertion of a clause in the London County Tramways (Electrical Power) Act, 1900, providing that the consent of the several road authorities must be obtained to the use of an overhead system of electric traction in metropolitan districts. This clause, which became Section 23 of the Act, was not accepted in ignorance, because the County Council was aware of the definite intention of the Lambeth and Wandsworth local authorities to resist the introduction of the overhead-trolley system.

It must be remembered, too, that it was through the districts of these two authorities that the County Council proposed to construct the first electric tramways in London, and that other road authorities were also opposed to the use of overhead wires. The County Council now find, however, that the right of veto given to the borough councils is a millstone around their necks, and as the former are merely the tramway authorities and the latter are the road authorities, the borough councils are the masters of the situation in regard to tramways in general, and in respect of the use of overhead wires by virtue of the before-mentioned Section 23 of the Act. The fact that this power of the borough councils hampers the promotion of electric tramways has only been recently recognised in official circles, and its admission is due to the endeavours put forth by the County Council to establish the overhead-trolley system on certain of the lines which are leased to the North Metropolitan Tramways Company in the northern and eastern parts of London. The desire to install the trolley system may be attributed partly to the considerably greater expenditure incurred in the construction of the conduit method per mile of track, and partly to the engineering difficulties encountered on the north of the Thames, combined with the narrowness of some of the thoroughfares. But the majority of the borough councils concerned refuse to permit the establishment of overhead wires, and hence the wish of the County Council to secure the recision of their right of veto.

The London County Council is certainly courageous if it thinks that Parliament will consent to the proposal to be made in the ensuing session to relieve the Council of the obligation to obtain the permission of the road authorities to the employment of aërial wires for tramways. Almost every one who has to journey to and fro daily deplores the lack of adequate transport facilities along most of the existing tramway routes; but how can an elected body, which has for years retarded the progress of tramways which companies were prepared to construct, and which agreed to submit to the wishes of the road authorities, expect that Parliament will relieve it of responsibilities which it assumed with its eyes wide open only four years ago? We do not say that as the tramway authority the County Council should not be allowed to convert the existing tramways to the conduit or the trolley system in the suburbs, but the fact that it is not the road authority, and that by Sec. 23 the County Council has strengthened the position of the borough councils, cannot possibly improve the position of the County Council itself. How can the latter ask for that which it has steadfastly refused to accord to others for years past? How can it hope for a parliamentary reversion of policy of four years ago? How can it be expected that pending the publication of the report of the Royal Commission on London Traffic, Parliament will be induced to grant omnipotent powers in regard to London streets, when nearly everybody believes that the future transport facilities for London must be by means of underground and not by surface lines? How can the County Council ask for a removal of the veto of road authorities when other tramway promoters, equally as well as the tramway-promoting County Council, are suffering from the same cause in different parts of the country? If the veto in regard to tramways and methods of traction is to be removed, it must be by legislation in respect of the whole country. The past-masters in blocking tramway progress can surely not be given facilities which do not exist in any other part of the country. If London is to be relieved, tramway promoters in the provincial towns have an equal claim for consideration with the retarding agent of electric traction on London tramways during the past decade.

MUNICIPAL MONOPOLIES IN PARIS.

IF there are conditions under which public transport, lighting, and other services could be conveniently and profitably carried out by a municipal council, they would seem to exist in Paris, where, until quite recently, the methods of dealing with traffic were more defective than in any other city in Europe, and the price of gas was nearly twice as much as it was in London, while even now the cost of electricity is so high that its use is limited as much as possible. The Paris Municipal Council saw an excellent chance of making a clean sweep and taking over all these different services, with the profits attached to them. It started with the transport service and followed up with the gas; but, having got far enough to see the practical results of a monopoly, the Council is beginning to doubt whether, after all, these enterprises are so profitable when they pass into the hands of newly created municipal departments. The idea of taking over the omnibus service on the expiration of the present monopoly seems less attractive in view of the heavy losses sustained by some of the tramway companies, as the result principally of experimenting with defective electric systems, and although the Municipal Council has been authorised to take over the omnibus monopoly in 1908, it is by no means improbable that it will renew the contract with the existing company, or make over the concession to some other concern, under conditions more satisfactory to the public. It could hardly improve upon the arrangement with the Metropolitan Company, whereby the Council made the tunnels and cuttings, and thus obtained a part ownership, as well as a participation in the profits, until the expiration of the concession thirty years hence, when the lines will revert to the Council. In the case of the gas monopoly the situation is by no means encouraging. During the few years that have yet to elapse before the monopoly expires the company is obliged to sell gas at 20 centimes per cubic metre, any loss to the company from this reduction being made up for out of the rates. Although this is a very curious way of cheapening gas, the consumer is so well satisfied with the intervention of the Municipal Council that he approves of its taking over the monopoly when the time comes. When the question of gas was discussed by the Municipal Council it was proposed, at the same time, to take back the concessions from the six private concerns on their expiration in three or four years' time. The Chamber of Deputies has authorised the Council to work the electrical service on its own account, and the matter is now before the Senate; but a large number of councillors are of the opinion that the municipal working of these services is being carried too far. They have good grounds for their opposition in the losses sustained by the municipal power station which supplies electric light to the central markets. Meanwhile the six private companies—Edison, Clichy, Eclairage et Force, Air Comprimé, Champs Elysées, and Rive Gauche—refuse to lay down any more mains, or improve their installations in any way, as they consider that they will not be able to get back their capital during the three or four years the concessions have still to run, and they are so far limiting the expenditure that some of them are even unable to accept new customers. Electricity for lighting and power purposes is so costly in Paris that the Municipal Council had hoped to treat with the companies under the same conditions as it did with the gas company, that is to say, to arrange for a reduction in the price of current on condition of the council making up for the difference in case of loss. Unfortunately, such an arrangement seems out of the question in view of the fact that a cheapening of current would inevitably bring in a considerable number of new customers who could not be supplied with the present limited installations. As the Council is unable to come to a decision as to whether it will renew the concessions or take over the working of the electrical service itself, a technical commission has been appointed to go thoroughly into the question, and it is hoped that an arrangement will be come to for a proper distribution of cheap current, although it is evident that, in any case, the work of laying down new plant and new mains could not be terminated in less than eighteen months or two years. It will thus be seen that the problem of the municipal working of the various services is presenting very serious difficulties. The principal drawback is that the Municipal Council is an ideal employer of labour from the workman's point of view, in the sense that the higher positions are something of a sinecure, owing to the number of engineers employed, while the workmen in the municipal service have better pay and shorter hours than in the private industry. This is all very well as a means of creating a higher standard of labour, but it is not always conducive to economical working.

DOCKYARD NOTES.

THE cruiser Theseus has been ordered from Gibraltar to Devonport to pay off. Her crew will turn over to the new cruiser Cornwall.

THE changes now going on with ships in commission are of a drastic nature, and they are attributed to Admiral Fisher, who is understood to hold the theory that protected cruisers and such craft are of no use to-day, and that British squadrons should all be armoured. It is certainly the common-sense view. We have often pointed out in this column that sloops and such-like craft are perfectly useless, and old cruisers no better. They cannot fight and they cannot run away, and it is a matter of considerable congratulation that the authorities seem at last to have determined to have our fleets war fleets.

SEVERAL of our ships which have just come home have been seeing the Baltic Fleet down Vigo way and Tangiers. The general impression of the crews is that they are smarter at ordinary evolutions than was expected, and their general efficiency is regarded as "better than the average for Russians." The stolidity of the men is much commented on. The final impression is that the fleet fully intends to go right out to the Far East and fight when it gets there. As to the results of that fighting, the general tendency is to abstain from prophecy, which seems (while savouring of optimism) to be fairly prudent.

THE Hannibal in her last prize firing did 14 hits out of 17 rounds with a 6in. gun. A bluejacket crew were the winners. On the average it is the marines who, relatively to their numbers, man the winning gun.

A NEW model yard is to be built at St. Petersburg at a cost of £100,000.

JAPANESE newspapers state that in their repairs at Port Arthur the Russian ships use zinc to patch holes.

INSTITUTION OF ELECTRICAL ENGINEERS, LEEDS LOCAL SECTION.—By the kindness of Messrs. W. T. Glover and Co., Limited, of Manchester, and the Lancashire and Yorkshire Railway Company, a visit has been arranged for the 19th inst. to the cable works of the abovenamed firm, and also to the Formby power station of the Lancashire and Yorkshire Railway.

A MECHANICAL WOOD-WORKER.

We give herewith illustrations of a new and ingenious mechanical wood-working machine that has recently been designed and manufactured by Messrs. Wadkin and Co., Evington Works, Leicester.

The machine possesses features of more than ordinary interest to all interested in wood-working manufactures, as it is to them the same as the milling machine is to the mechanical engineer. The great variety of work which this machine is capable of doing renders it most valuable not only in large shops, but also in small ones, where there is such a variety of work that it would not pay to keep special machines for each class of work done. The mechanical wood-worker—Fig. 1—takes up a comparatively small area, and can be used economically on almost any class of work with the exception of sawing, planing, and thicknessing; and although it is difficult to state its capabilities in detail, the following important and useful operations will give some idea of the range of work the machine is capable of performing:—Regular and irregular moulding, tenoning, dovetailing, boring, turning, trenching, tracery fluting, and moulded work of every description, and all classes of millwrighting and patternmaking. An illustration is given in Fig. 3 showing work actually performed on the machine. The machine consists of a massive solid frame supporting a long rocking arm carrying the spindle head, and a cast iron table running on rails that are part of the main bed-plate. The frame is made of cast iron, and is very

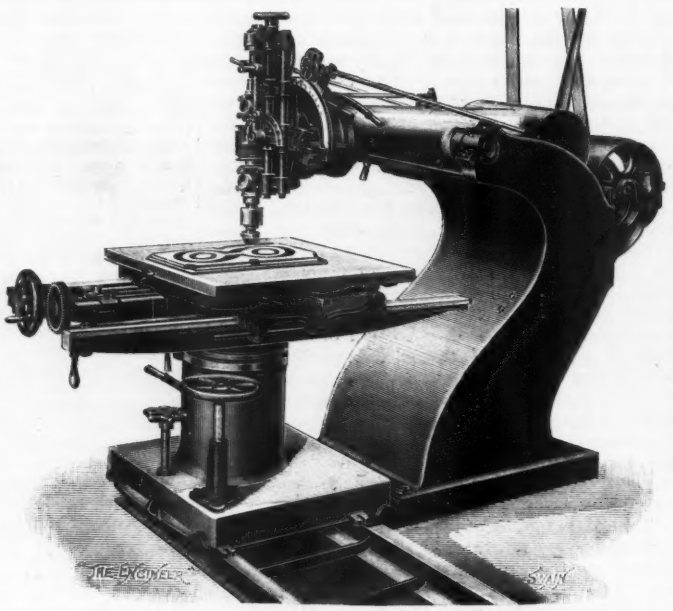


Fig. 1—THE WADKIN WOOD WORKER

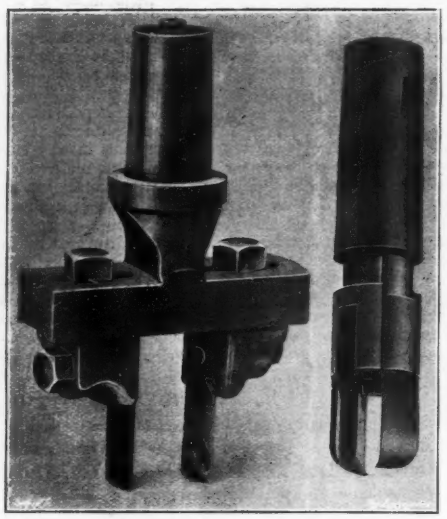


Fig. 2- WOOD-WORKING CUTTERS

strong and heavy, so as to prevent vibration as much as possible. Two brackets for carrying the countershaft are bolted on to the back of this casting; and on the top are two trunnions, A A—see the opposite page—for supporting the rocking arm, which is made of cast iron, circular in section, and sensitively balanced. It has a vertical movement of 16in., and can be set at any angle required in that range. A large spindle head is carried at the front of the arm and is fastened to it by bolts. It can be turned through any angle from the vertical to the horizontal, a graduated scale B being provided in order to enable the head to be fixed at any definite angle. The vertical movement of the spindle is obtained practically in the same way as in a drilling machine, and is so arranged that a definite feed can be given to it as desired, and is regulated by the sector S shown in the drawing. This is of great importance, especially in trenching work. The handle C is used for raising or lowering the spindle, the device being both quick acting and positive in its movement. In addition to this, there is a micrometer screw adjustment for fine work. A pulley driven by a belt from the countershaft is keyed on to spindle, and to allow for the vertical movement of the head there are compensating pulleys in the rocking arm. As there is a greater force exerted on the lower side of the bearings supporting the spindle owing to the pull of the belt, great care had to be exercised in their design. To allow for this greater pressure and to ensure smooth running, the half of the bearing which is subjected to the greater force has been made of phosphor bronze, and the other half, which forms the lubricating cap D as well, is arranged for white metal, which can be easily renewed at any time. This bearing has been well tested, and has proved to be most satisfactory. The striking lever is arranged in a convenient position immediately behind the spindle head and in easy reach of the operator; it can also be operated from either side of the machine. The table consists essentially of two parts—the supporting column and the table itself. The column is made of cast iron, carried on rollers which run along rails fastened to the concrete foundation. The table receives its motion along the rail by means of a pinion keyed on to the spindle S, which gears into a bevel wheel fixed to one of the rollers. It can be held in any position along the rail by simply screwing up a clamp T, which grips the rail. An accurately-turned cored column, which exactly fits the circular recess in the main body, is used for carrying the table. It is supported on a telescopic screw resting on a nose $\frac{3}{4}$in. diameter, N, which works in an oil bath. The vertical motion is also actuated by this screw passing through a threaded sleeve, which is cast into a column, and this column enters the main casting sufficiently to allow a vertical movement of 12in. If this is added to the 16in. through which the rocking arm works a total range of 28in. is obtained. In addition to the movement of the body the table has also a lateral and cross-section motion, which is regulated either by a screw or a quick hand adjustment. This is accomplished by having a split nut fixed to the table and worked by the leading screw, which can be instantly released, and the table pushed forward by hand. Besides the several movements already mentioned, the table can be turned through a whole circle horizontally. Automatic stops are used throughout the machine, thus facilitating and ensuring accuracy in repetition work. It will be seen from the description given that the machine has a nearly universal movement and a large range of action. This dispenses with a large number of special devices and jigs, which would otherwise have to be made, and, consequently, the work can be produced at a minimum cost. The machine is driven in the usual manner from the main shafting, there being two loose pulleys, one for direct and the other for cross belt, and a fixed pulley in the centre, keyed on to a hollow countershaft, with sight-feed tell-tale lubricators, which automatically lubricate the loose pulleys. Some of the machines are electrically driven. In this case the motor is fixed on to the countershaft brackets, and the driving is taken direct from the motor. A feature in connection with this woodworker is the ingenuity of the cutters. They are made of special steel, and in such a form that they will maintain their cutting edge in a state of efficiency longer than most cutters. The reason for this is that they are sharpened and ground on their inside edge. They are also interchangeable. The expanding grooving disc cutter—Fig. 2—is a tool which is worthy of special mention. It works on the differential screw principle, and will expand four times its normal size—that is, from three-sixteenths to three-quarters. A graduated scale is marked on the tool, to enable any required width of cut to be obtained. The stop trenching cutter is also neat. It expands from $\frac{3}{4}$in. to 1$\frac{3}{4}$in., and as the cutters are independent from the main part of the tool, they can be easily removed and economically replaced in the case of breakage. A great variety of cutters, adapted to all classes of work, and made and standardised so that they can be obtained without with a minimum of delay. Special tools can also be made to suit any class of work. For simplicity and cheapness a large number of the tools are merely fly-cutters. But although their cutting edge is at right angles to the work they are doing, they cut well, leaving a clean, smooth surface, requiring very little sand-papering afterwards. This class of cutter has been so designed that in some cases they can be adapted for cutting different sized holes; and also so that different cutters can be used on the same spindle. Besides the few already mentioned there are many other interesting cutters, designed for all classes o work. Large cores up to 12in. diameter can be cut with ease. Routing cutters are made for routing out the heavy bodies of patterns, and these will take a cut of 1$\frac{1}{2}$in. at a time. Gear cutting can also be done, the methods being the same as on a universal milling machine, the correct spacing being obtained from a leading screw on the table, geared into a dividing head in the ordinary way. In doing spiral work the job is practically milled. The cutters revolve in the same manner as on a milling machine, the working also turning slowly between the centres of the dividing heads. Curves can be cut up to 8ft. diameter, but by using a simple "forming" apparatus any radius desired can be worked. The machine takes up little space, and is easily managed, which is always a great consideration in adopting new machinery.

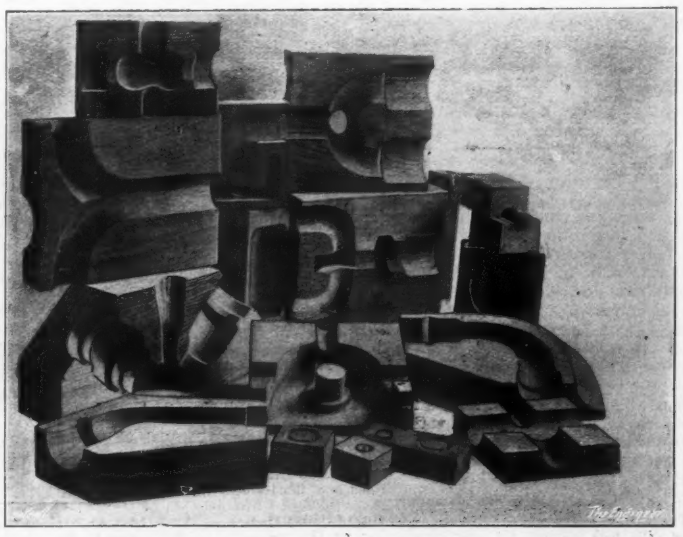
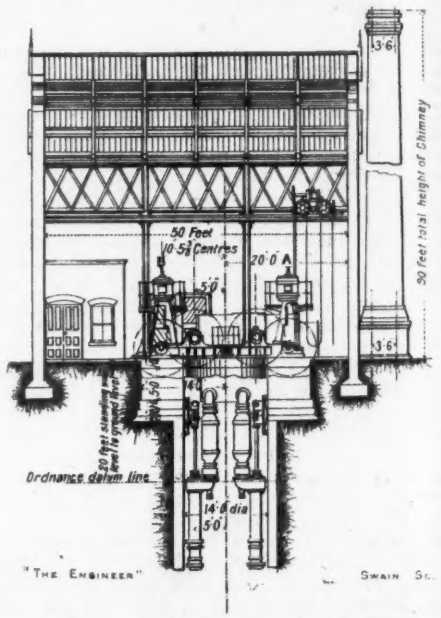


Fig. 3—EXAMPLES OF WORK

PUMPING PLANT AT CHATHAM DOCKYARD.

Our two-page Supplement and the engraving on this page show two sets of high-duty pumping engines, designed and constructed by Messrs. Hayward-Tyler and Co., of London, and supplied, with the necessary boilers, &c., to H.M. Dockyard, Chatham.

The installation consists of engines and pumps in duplicate. The engines are of the vertical, inverted, triple-expansion, surface-condensing type, have cylinders 9$\frac{3}{4}$in., 14$\frac{1}{2}$in., and 23$\frac{3}{4}$in. diameters by 24in. stroke, with piston valves to the high-pressure cylinders, and having specially designed link motion to effect a variable expansion, adjustable by hand, while the engines are running. The medium-pressure cylinders also have piston valves, while the low-



PUMPING STATION, CHATHAM DOCKYARD

pressure cylinders have double-ported flat type valves with balancing cylinders. The receivers and all steam and exhaust pipes are of copper, so designed as to readily allow of expansion without undue stress. The air pumps are of the bucket-and-plunger type, with metallic valves, the pumps being driven off the main crank shaft by crank arm and rods. The condensers are of the surface type, and are situated one on each pump rising main, with by-pass pipes and valves to enable either condenser to be isolated at will. Each surface condenser is fitted on its top with a jet condenser provided with an injection-valve arrangement from the pump main, so that this can be used in case of stoppage of the surface condensers. The air pumps have an adjustable stroke, so as to allow of the extra water being dealt with when the jet condenser is at work.

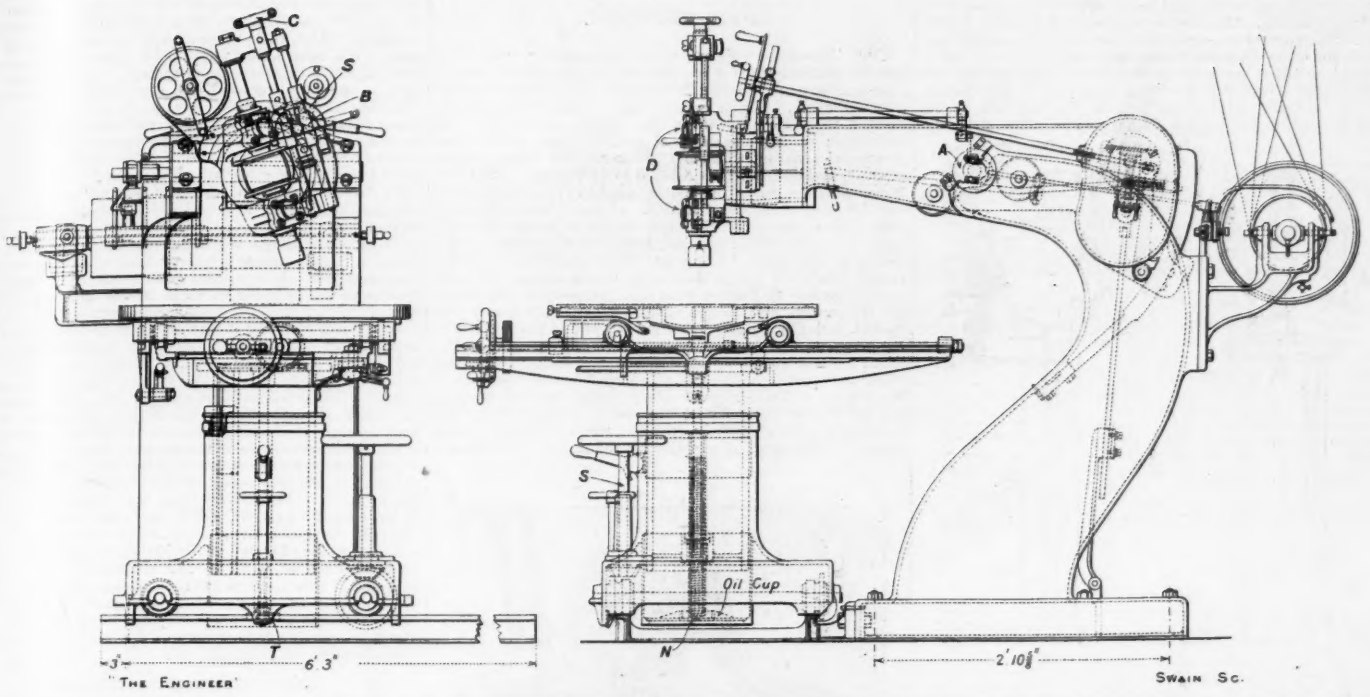
The main pumps are situated in a well 14ft. 6in. diameter, on stout girders, and consist of treble gun-metal-lined barrels, 16$\frac{1}{2}$in. diameter, 36in. stroke, with gun-metal double-seated buckets and suction valves. Doors are provided, so as to permit of access to all the valves. Retaining valves, with air vessels and dip pipes, are placed on the delivery pipes in the well.

The pumps are driven from the engines through spur gearing having machine-cut teeth, the wheels being mortised with beech cogs. The top gear of the engines and pumps is arranged on a common and massive cast iron framework securely nippled and bolted together. The cranks throughout

MECHANICAL WOOD WORKING MACHINE

MESSRS. WADKIN AND COMPANY, LEICESTER, ENGINEERS

(*For description see page* 502)



are of the three-throw slab type, the "throws" being cut out of the solid. Connecting and motion-rods are of steel forged from the solid bar, no welding being done. All rotating bearings are of Messrs. Hayward-Tyler and Co.'s special anti-friction metal mixture.

The boilers are two in number, and are of the multi-tubular type, with central combustion chamber. They are fitted with asbestos-packed fittings, and with auxiliary duplex feed pumps, in addition to the main boiler feed pumps on the engines. The working steam pressure is 155 lb. per square inch The requirements which the plant had to fulfil were as follows:—

Each set was to deliver 1,000,000 gallons of water per twelve hours against a vertical head of 232ft., including friction through one mile of 15in. bore delivery main when running at full speed, and 500,000 gallons per twelve hours against a vertical head of 273ft. through one mile of 9in. main when running at half speed. The guaranteed duty per 112 lb. of Welsh coal at full speed was not to be less than 96,000,000 foot-pounds, and at half speed not less than 90,000,000 foot-pounds. At the official trial held by the chief engineer and officials of the dockyard the whole plant was, we are informed, found satisfactory in every respect. On each twelve-hours' full speed trials a duty of 130,000,000 foot-pounds per 112 lb. of Welsh coal was obtained, and on each half-speed trial a duty of 96,000,000 foot-pounds per 112 lb. coal, with the engines running at 89 and 45 revolutions per minute respectively, and the pumps running at 18 and 9 revolutions per minute respectively. At full speed the coal consumption equalled 1·5 lb. per indicated horse-power per hour, and at half speed the coal consumption equalled 1·8 lb. per indicated horse-power per hour.

THE INSTITUTION OF CIVIL ENGINEERS.

COAST EROSION.

At the ordinary meeting on Tuesday, the 8th November, Sir Guilford L. Molesworth, K.C.I.E., President, in the chair, two papers were read, namely, "Coast Erosion," by A. E. Carey, M. Inst. C.E., and "Erosion on the Holderness Coast of Yorkshire," by E. R. Matthews. The following are abstracts of these papers:

The first paper points out that, in the struggle between sea and land, the frontiers of England are being continuously pushed back, but land wastage from this cause is a matter which is left almost entirely to those immediately concerned. If the bank of a river bursts, similar apathy does not prevail. Soot is levied and the damage is made good; but an irruption of the sea is, generally speaking, looked upon as a thing unavoidable and beyond control. The evils of the present lack of system are due to sporadic activity, an excess of authorities, and an absence of general control. The author describes the evolution of a seaside village, subject to intermittent inundation, into a watering place, in front of which it is sought to trap the whole of the travelling shingle, with disastrous results to leeward and frequently to the town itself when its borders are extended. He cites as an analogous situation the plight of riparian landowners, should one owner farther up-stream have the right to dam or divert a river at will.

The author suggests that a short Act clearly defining the law is the first requirement, and urges that a new body should be created, with the special function of dealing with the foreshores of England and Wales as a whole, unfettered by the restrictions now existing. He then details the functions and powers with which he thinks this "Coast Commission" should be invested, and points out that under the title of "mundbriech" the Cinque Ports formerly enjoyed similar rights under Royal Charters. He also suggests the division of the necessary expenditure between the Treasury, the local authorities, and the landowners, and the rights which should be conferred upon the Commission in the possible acquisition of foreshore lands, as well as their management.

He suggests that the Commission should appoint six district engineers or coast wardens for the following districts:—Berwick-on-Tweed to the north of the Humber; the south of the Humber to the Essex shore of the Thames; the Kent shore of the Thames to Poole Harbour—including the Isle of Wight; thence to the Severn, the Welsh coast, thence to the Scotch border.

He points out that one advantage of a single authority to deal with the entire coast line would be its capacity to make use of surplus shingle or other material to tune up a threatened coast line to safety. By this means, he thinks, safety could often be secured at a comparatively insignificant cost. The problem, if studied as a whole, would prove far less formidable than as now, when it has to be dealt with piecemeal. He shows how impossible it is in many cases for local governing bodies to do anything effective, owing to the magnitude of the problem, the conflict of interests, and the want of adequate authority.

The paper is not intended to set out the principles and practice of defence measures from an engineering standpoint, but to deal with the matter from the administrative side. It then briefly describes the actual coastal conditions along the six districts enumerated, the principal localities of active coast erosion being from Bridlington to Spurn Point, and along the East Anglian coast.

In connection with the accretion of shingle at Dungeness, the author points out that apparently the rate of accretion is diminishing. He attributes the growth of this accretion primarily to deep sea currents rather than to littoral movement, as the addition to the volume of Dungeness appears to be about 200,000 tons per annum, whereas the quantity of shingle in circulation west of Hastings is only 60,000 to 70,000 tons per annum, and merely a small portion of this passes to the eastward.

By means of a skeleton map, the geological stratification along the coast line of England and Wales is shown, also the principal localities of erosion. The author points out that if Professor Darwin's view, on astronomical grounds, that the tides had, within geological times, a vertical range twice as great as at present, be correct, it helps to explain existing coastal phenomena. He holds as not proven the theory that within the historic period any general or local subsidence of the sea bottom has taken place. From the position of Roman coins discovered at Rossall it is inferred that there the level of sea and land has remained constant since the period of the Roman occupation.

The author briefly enumerates the salient geological features of the coast line, and points out their connection with the relative rates of erosion. He then deals with the artificial causes of erosion, and quotes the report of the British Association for 1895 that this is largely due to the abstraction of materials from the foreshore and the construction of badly designed preservation works. As a guide to the solution of the general problem, a statement is given of the practice in other countries with regard to the rights and obligations of the State in foreshore questions.

In conclusion, the author details the efforts in 1903 of the East Anglian municipal authorities to deal by united action with the question on that coast. These have resulted in absolute deadlock; owing to the absence of expert opinion, neither the Board of Trade nor the local committee being prepared to initiate measures of defence. Meantime, the ravages of the sea are unprecedentedly severe.

The second paper deals with the effects of erosion on the most strongly attacked portion of the English seaboard, namely, the coast between Bridlington and Spurn Head, and gives an account of the remedial measures which have been adopted at Bridlington and at other towns, and of their effects upon the foreshore. Almost the whole of this coast line is being eroded at an average rate of about three yards per annum; and on the assumption of continuous erosion at that rate it is calculated that 115 square miles of land have disappeared between Flamborough Head and Kilnsea—a distance of 40 miles—since B.C. 55; and in that time the sea has encroached upon the land 3¼ miles. The bed of the sea is also being eroded. The eroded material is carried in a southerly direction, and much of it is deposited at Spurn Point; but the author is of opinion that a large portion finds its way into the estuary of the Humber, and that some of it even crosses that estuary and is deposited on the Lincolnshire coast.

The paper describes the various works that have been carried out from time to time, with the object of protecting the coast, at Bridlington, Hornsea, Withernsea, and Spurn Point. During the past thirty-five years the Corporation have spent about £73,000 in protecting the north foreshore of Bridlington, the south foreshore being maintained by private landowners. The sea defence works at Bridlington consist of sea walls, built along the shore, and groynes, projected across the foreshore either at right angles to the coast line or approximately so. Some of the walls are constructed of timber, with a filling of block chalk; others are of concrete and masonry. Their design is described and illustrated in detail.

The earlier heavy timber groynes, consisting of timber frames filled with chalk, proved fairly effective in breaking the force of the waves, but were too high to have proper effect in causing accretion on the foreshore. The later construction of four long low timber groynes, however, had the result of causing, within three years, the accumulation of 500,000 tons of sand on the foreshore, raising the beach to an average height of about 4ft. over an area of 26,000 square yards; and a further nine groynes of the same kind have had a similar effect. The protective works at Hornsea consist of groynes and timber breastwork, carried out by private enterprise. At Withernsea, six groynes and a sea wall along the whole frontage have been of great service in maintaining the foreshore. The timber groynes erected by the Board of Trade between Kilnsea and Spurn Point and at the Point have been very successful, and have resulted in the accumulation of an immense quantity of shingle and sand.

The author then proceeds to consider what measures are needed for the protection of the whole of the Holderness coast, and suggests that a continuous permanent sea wall along the whole length and also ten long groynes per mile would be required. He is of opinion that the latest type of sea wall and groyne constructed by him at Bridlington would be suitable, and he finds that the cost of the suggested works on this basis would be about £1,247,000, of which £110,000 would be for groynes. On the other hand, the value of the land swallowed up by the sea in the thirty-three years' life of the groynes would be about £34,000, or only about one-third of the cost of the groynes alone. Consequently, it is impossible that the landowners should bear the cost of protection, and the question naturally arises, "Who should bear it?" The author strongly urges that this is a matter of national importance, and that just as the Board of Trade protects Spurn Point and four miles of coast line adjoining it, so the whole of the coast line between Kilnsea and Bridlington should be protected by them against the inroads of the sea.

The paper concludes with some particulars of what is being done by Government in Holland and Belgium to protect the foreshores of those countries, and of the amount of money devoted by the Belgian Government to such work; also with statistics of the loss of land throughout Great Britain in the years 1867-1900.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

STEAM TURBINES.

SIR,—It was recently stated at the Institution of Mechanical Engineers, that in order to reduce the velocity of rotation, it might be found feasible to mount the diverging nozzles in such a way that they would rotate in one direction while the vane wheel rotated in another.

I wish now to ask for information as to how to calculate the thrust due to reaction in diverging nozzle. I can find nothing whatever about this which is of the slightest use in any existing treatise. Indeed, no one seems to have thought the question worth consideration.

There is, of course, no trouble when we have a parallel adjutage, but the figures must, I think, be quite different for a diverging nozzle.

I may add that it would be worth while to define the proper curve for these nozzles. I was present at the reading of Mr. Neilson's paper, and I noticed that during the discussion this question of form was raised and left undiscussed. Now, many years ago various experiments were carried out, notably by Messrs. Holden and Brooke, to settle the proper form for the exhausters used with the vacuum brake. These exhausters used to form a somewhat conspicuous feature on locomotives twenty years ago. A record of the experiments must remain somewhere, and would, I suppose, apply to the turbine. TESTOR.

Belfast, November 11th.

ACETYLENE GAS ENGINES.

SIR,—I believe the practical problem of an engine driven by acetylene gas is so far unsolved; if this is so I should like to know why. I have heard it ascribed to imperfect combustion resulting in excessive carbonisation. If this is the case, where does the carbonisation take place—in the cylinder or in the admission port? At any rate, this ought not to be an insuperable difficulty. Possibly the question of cost of the fuel is the dominant factor in the suppression hitherto of the acetylene engine. It is obviously impossible to put on the market a gas engine the fuel of which costs about nine or ten times as much as ordinary coal gas, unless it can be shown that it has an explosive force as much higher than coal gas as its price is. Perhaps some of your scientific contributors can tell us something about this; the whole question appears to me very interesting, and I believe there are many like myself who would like to see this matter carefully discussed. FRANK EAMES.

Midhurst, November 8th.

A WATER-SEAL STEAM TRAP.

The accompanying engraving—Fig. 1—is an illustration of a new water-seal steam trap, which is manufactured by the Industrial Improvements Company, 2, Jewry-street, E.C. The design is entirely different to the general type of separators and discharge valves, and many advantages are claimed for this apparatus. The construction, which is simple, is briefly this:—The apparatus consists of a head A, with an inlet and outlet the same diameter as the main steam pipe, so that it can be inserted at any point in that line. There are also two baffle plates B—see Fig. 2—which form part of the casting, having two drain holes at the bottom. At one side of the head is a casting forming the discharge valve. The construc-

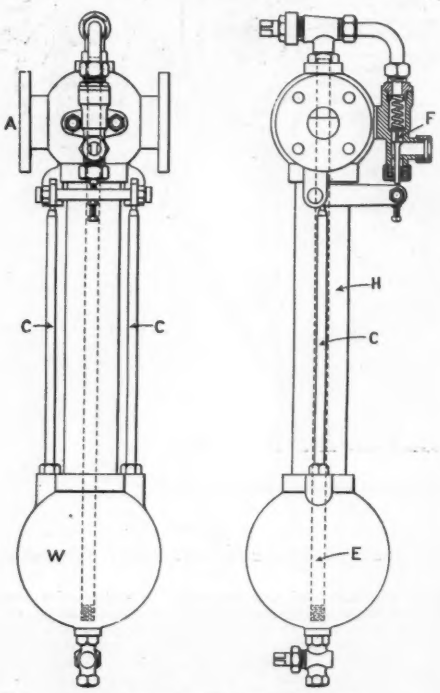


Fig. 1—WATER SEAL STEAM TRAP

tion of this can be readily seen from Fig. 1. Screwed into the head, in a vertical position, is the sensitive tube, which is made of gun-metal, and varies in length from 8in. to 16in., depending upon the size of the trap. The diameter of this tube is never less than that of the main steam pipe. Attached to the lower end of the sensitive tube is the spherical water-seal trap. Two steel rods C are screwed into lugs cast on to this portion, and are of such a length that they just touch the lever D at a distance from the fulcrum equal to one-ninth the length of the lever. By this arrangement it will therefore be seen that any upward movement of the rods C will lift the discharge valve F. A pipe runs from the discharge valve connection at the top of the head, through the sensitive tube, nearly to the bottom of the trap. The action of the trap will now be

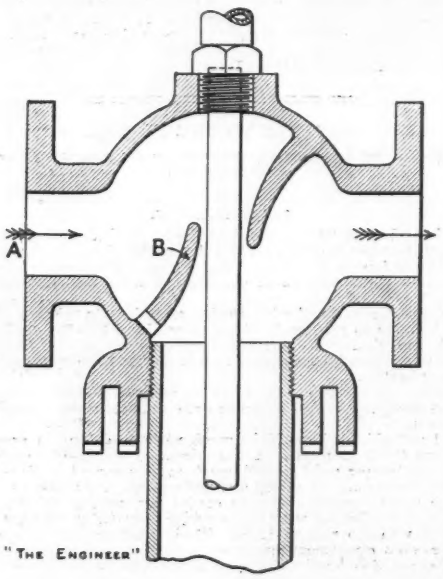


Fig. 2—HEAD OF STEAM TRAP

understood. Wet steam and water pass along the main pipe, and enter the apparatus at A; water then passes into the trap through the recess in the baffle plate. The water which is carried on in suspension passes through an area larger than that of the steam pipe, and further separation results. This water drops into the trap by gravity, and dry steam passes along. The apparatus is therefore a separator as well as a trap. The water-seal chamber gradually gets full of water, which then creeps up the sensitive tube. This water, coming in contact with the gun-metal, slightly cools it, and contraction takes place. The rods C are thereby raised, and the discharge valve opened. Water immediately flows up the discharge pipe and through the valve. By this means the water soon leaves the sensitive tube, and is replaced by steam. The temperature rises, the tube expands again, and the valve is consequently closed. This cycle is then repeated. It is stated that the water never fills the sensitive tube to a greater height than one-third, nor does the trap ever totally empty itself, and, as the open end of the discharge tube is always under water, the steam is trapped, and cannot possibly escape.

TOOL GRINDER.

The illustration given below represents a new tool grinder, possessing one or two original features, which Messrs. Luke and Spencer, Limited, Broadheath, Manchester, are now manufacturing. It will be seen that the machine is of substantial proportions. One of the objects aimed at is the prevention of the splashing of the workman during the process of grinding tools, and the amount of water used to keep the tool cool has been reduced to a minimum. The rest for the tool now serves the double purpose of rest and sprayer. On the top of it are a number of small holes, bored at such angles that when the water supply is pumped through them it rises in the form of jets, meeting in the plane of the centre of the wheel. These jets do not play directly on the emery wheel, but rise to their summit and commence to fall before coming in contact with the periphery of the wheel. By this means any motion due to gravity is practically prevented, and the water reaches the wheel and the tool at the same time in a state of comparative rest. From each of the small holes a groove is cut towards the emery wheel, and when the tool is being ground at least one of the holes is blocked up, and water passes along under the tool, keeping the lower side cool, whilst the water sprayed from the remaining holes completely envelops the face which is being ground. The water is supplied to the rest by a centrifugal

pump at the base of the machine, which drives the water through a flexible pipe into the top of the rest. The body of the machine forms a cistern, and the water after being used is returned into it. A strainer between the body of the machine and the pump prevents any dirt or mud from returning to the cistern. In the trough of the grinder a weir is formed from side to side, which collects a shallow pool of water in the bottom of the trough, so as to prevent any splashing due to the water being carried round by the wheel. A specially-designed hood directs this water down the side of the rest, which is shaped for this purpose, and meeting the small pool of water, practically no splashing takes place similar to that which would occur if it rebounded from an iron tray.

ROLLER AXLE-BOXES.

Six years ago the late Mr. Billinton began to try roller axle-boxes on the London and Brighton Railway. The bearings were supplied by the Roller Bearings Company, Limited, formed in 1896. The results were considered satisfactory, but the great cost of the axle-boxes was prohibitive, and the matter dropped for the time. In 1900 a new company, under the title of the Empire Roller Bearings Company, Limited, was formed, with Major-General Hutchinson, C.B., R.E., as chairman. The new company took over the business of that first named, and has succeeded in reducing the cost of axle-boxes to a reasonable sum. An experimental train has been run on the London and Brighton line for about two years, during which it has traversed 80,000 miles, with results so excellent that General Hutchinson asked a number of engineers and others interested in railways to see this train and make a run in it from London Bridge to the Crystal Palace, where luncheon was provided. Among those present were Sir W. H. White, Prof. Unwin, Mr. James Holden, Mr. W. G. Marshall, Mr. C. Morgan, engineer to the London, Brighton, and South Coast Railway, Mr. T. Cooper, Sir Alexander Binnie, Lieut.-Col. Yorke, and Dr. Tudsbury. Opportunities were given for the examination of the bearings, which appear to have suffered nothing from their long service.

The axle-boxes are very neat, and do not take up more room than the normal box. The axle journals are 8⅛in. long and 4in. diameter; on each journal is fitted tightly a steel sleeve, $\frac{7}{16}$ths of an inch thick, quite parallel; the rollers are perfectly plain steel cylinders, ⅞in. diameter and about 8in. long. There are fourteen of them in each box. They are kept parallel to each other and the shaft and prevented from touching by a light cage. There is nothing special about the arrangement, which is, as we have said, very neat.

The advantage claimed for these roller bearings are that the trains can be very easily started from rest, as there is no static friction to overcome. Indeed, the starting resistance of the trains is reduced to about 3 lb. per ton. We see no reason to doubt that this claim is well founded. The train on its run to the Crystal Palace started very easily, and with remarkable freedom from jerks. A further claim is made that the consumption of fuel is reduced 10 lb. per mile. As we have no figures before us we must rest content to reproduce what we have been told, no doubt in all good faith. We believe that very careful experiments are to be made to settle this question definitely. The system has now been in use experimentally for some time on tramcars in Croydon, Southport, Hull, Liverpool, and Sheffield. The great difficulty has always been, with roller bearings, to hit on the right proportions and the proper materials; and this, it would seem, the Empire Roller Bearings Company has, after a very considerable outlay, succeeded in doing.

So far as we can see, the new bearings are a complete mechanical success. It now remains to determine their commercial value to railway and tramcar companies. They are more expensive than the normal bearing, but if they possess the advantages claimed for them they will very quickly pay for themselves. In any case, we think it likely that a good deal more will be heard of them in the immediate future. If they do not turn out a financial success, then no roller bearings ever will, and it may be taken as settled that roller bearings are out of place on rolling stock of all kinds. As bearing directly on the question of resistance, it is worth while to reproduce here the results of some experiments carried out by Professor Goodman at the Yorkshire College. He found that the friction per ton of load decreased as the load increased. Under a pressure of 1000 lb. at 40 revolutions, the bearing friction was at the rate of 8·512 lb. per ton of load, but under a pressure of 10,000 lb. at the same speed the friction had decreased to 3·584 lb. per ton of load. That speed has very little effect upon the coefficient of friction. In the case of a load of 1000 lb. the coefficient was constant between the speeds of 40 and 480 revolutions per minute; and in the case of a load of 10,000 lb. it varied from ·0016 at 40 revolutions to ·0013 at 160 revolutions, and remained constant at this figure to 480 revolutions, the highest speed obtainable at the trials. That the slight friction to be overcome in starting was practically the same as the running friction; and that the end thrust of a correctly constructed roller bearing was practically nil.

LAUNCHES AND TRIAL TRIPS.

Adamton, steamship; built by, Northumberland Shipbuilding Company; to the order of, Messrs. John Cory and Sons, Limited; dimensions, 305ft., 46ft. by 21ft. 7½in.; to carry, 4000 tons; engines, triple-expansion, 22in., 36in., and 50in. by 39in., pressure 160 lb.; constructed by, Richardsons, Westgarth and Co.; a speed of 10½ knots was attained; trial trip, November 4th.

Rags, steel screw steamer; built by, Wm. Gray and Co., Limited; to the order of, Mr Hans B. Olsen; dimensions, 352ft., 48ft. by 27ft. 4in. depth; engines, triple-expansion, 24½in., 40in., and 65in. by 42in. stroke, pressure 180 lb.; constructed by, the builders; trial trip, November 5th; 11¼ knots.

Pontop, steel screw steamer; built by, Messrs. Furness, Withy and Co., Limited; to the order of, Messrs. The Peareth Steamship Company, Limited; dimensions, 335ft. long; engines, triple-expansion, 23½in., 38in., and 64in. by 42in. stroke, pressure 180 lb.; constructed by, Richardsons, Westgarth and Co.; launch, November 7th.

Nerite, oil carrying trunk steamer; built by, Sir W. G. Armstrong, Whitworth, and Co., Limited; to the order of, The Shell Transport and Trading Company, Limited; dimensions, 258ft., 46ft. by 18ft. 3in.; to carry, nearly 3000 tons on a light draught; engines, triple-expansion, 20½in., 33in., and 54in. by 36in. stroke, pressure 180 lb.; constructed by, the Wallsend Slipway and Engineering Company; the Flannery-Boyd system of oil fuel burning is being installed; launch, November 8th.

Rosemount, screw steamer; built by, Northumberland Shipbuilding Company, Limited; to the order of, Messrs. John Cory and Sons, Limited; dimensions, 335ft., 48ft. by 24ft. 3in.; to carry, 5200 tons; engines, triple-expansion, 23½in., 39in., and 64in. by 42in., pressure 160 lb.; constructed by, Richardsons, Westgarth and Co.; launch, November 10th.

Alcana, steel cargo steamer; built by, R. Craggs and Sons, Limited, Middlesbrough; to the order of, E. F. and W. Roberts, Liverpool; dimensions, 352ft. long, 47ft. 6in. and 27ft. 3in.; engines, triple-expansion, 24½in., 41in., and 68in. by 45in. stroke, pressure 180 lb.; constructed by, Geo. Clark, Limited, Sunderland; launch, November 12th.

Royal School of Mines.—The first dinner for Royal School of Mines men resident in South Africa, which it is hoped will become an annual event, was held at the New Club, Johannesburg, on Saturday, the 8th October, 1904. The chair was to have been taken by Mr. Weldon, Acting Commissioner of Mines, who at the last moment was prevented through ill-health from being present, and, in his absence, Mr. A. R. Sawyer, president of the Geological Society of South Africa, presided. Amongst those present were H. E. Bradshaw, C. B. Brodigan, G. Carter, E. H. Clifford, F. H. P. Creswell, A. M. M. Cooke, De Chazal, P. D. Durell, J. Duncanson, H. M. Eddowes, M. Fergusson S. E. Fletcher, S. H. Ford, L. C. Franck, A. Goldwater, H. D. Griffiths, E. Hay, C. Baring Horwood, H. E. Hume, J. P. Johnson, C. F. Lamb, J. G. Lawn, H. F. Marriott, H. Meyer, D. Michaux, J. Morris, M. Park, H. Power, E. P. Rathbone, Reg. W. Robinson, H. F. Roche, R. A. Rouillard, C. B. Saner, P. Scholer, J. Sewell, F. Smith, R. B. Smith, U. P. Swinburne, R. B. Webber, D. Wilkinson, A. Wood. The following gentlemen were unfortunately prevented from attending:—F. L. Bensusan, A. J. Brett, D. L. James, J. I. Jameson, J. Harry Johns, H. L. Lezard, J. H. Lucas, P. Maxwell, J. H. Munnik, H. G. Nitch, A. E. Payne, Ralph Robinson, T. Simpson, C. M. Stewart, J. E. Vaughan, H. Weldon. After the loyal toast had been duly honoured, the chairman, Mr. A. R. Sawyer, in proposing the toast of the Royal School of Mines, laid special stress on the high tone imparted to that institution by its two mining professors, the late Sir Warington Smyth and the late Sir Clement le Neve Foster, which has made itself distinctly felt on all those who had the privilege of studying under them. It was also announced that the following telegram would be sent to the Dean, Professor Judd, of the Royal School of Mines, London:—"Royal School of Mines men met Johannesburg annual dinner Saturday wish Old School prosperity," which announcement was received with cheers. Other speakers were Messrs. E. P. Rathbone, J. G. Lawn, C. B. Brodigan, U. P. Swinburne, H. D. Griffiths, D. Wilkinson, H. F. Marriott, C. Baring Horwood, E. Hay, and F. H. P. Creswell, which latter gentleman, in a very able speech, referred to Professor Huxley having inculcated the necessity of the application of the scientific method to mining, and the importance of following the dictates of logical reasoning as opposed to forming hasty opinions on insufficient premises. He then went on to point out that the training at the Royal School of Mines was eminently of a character to fit its students thus to use their reasoning faculties, which point was also emphasised by Professor Lawn.

THE APPLICATION OF DRY-AIR BLAST TO THE MANUFACTURE OF IRON.*

By James Gayley.

The atmosphere, which plays such an important part in the manufacture of iron and steel, is the most variable element to contend with in its several processes; and particularly is this true of the blast furnace process, which consumes air in large quantities. At no time since the blast furnace became an important and widely-used apparatus—even when it was operated in the most crude manner—have the variations in composition of the raw materials used been as frequent and as great as the variations in humidity of the atmosphere. In furnaces using ore from the Lake Superior district the raw material, amounting to about 7200 lb. per ton of iron, varies in composition within 10 per cent., and is as uniform as human skill can make it, but the atmosphere, of which 11,700 lb. are consumed per ton of iron, varies in its content of moisture from 20 to 100 per cent, from day to day and often in the same day, thus rendering the process, even with the best appliances, an uncertain one, and dependent on the caprice of the atmosphere. The desiccation of the air used in blast furnaces to such extent as to cause a practical elimination of the moisture, or its reduction to a small quantity, and maintaining it uniform, must of necessity contribute in a very marked degree toward the attainment of uniformity in the furnace operations, and the advantages from desiccation can be appreciated only after due consideration is given to the volume of air that is consumed per minute, and the large amount of moisture which it contains.

It has been deemed preferable in this communication to express the quantity of moisture contained in the atmosphere, as grains of water per cubic foot of air, inasmuch as the quantity of air blown into blast furnaces is expressed in cubic feet. With air containing one grain of water per cubic foot, there is passed into the furnace for each 1000 cubic feet used per minute, practically one gallon of water per hour. The quantity of moisture in the air, taken from daily readings by the observer of the United States Weather Bureau at Pittsburg, is set forth in Table I.

Table I.

	Average temperature.†	Grains of water per cubic foot of air.	Gallons of water entering per hour into a furnace using 40,000 cubic feet air per minute.
January	37·	2·18	87·2
February	31·7	1·83	73·2
March	47·	3·4	136·
April	51·	3·0	120·
May	61·6	4·8	192·
June	71·6	5·94	237·6
July	76·2	5·6	224·
August	73·6	5·16	206·4
September	70·4	5·68	227·2
October	56·4	4·0	160·
November	40·4	2·35	94·
December	36·6	2·25	90·

The above table, like all records made by the Weather Bureau, is from observations taken on the top of a high building, and does not correctly indicate the condition of the atmosphere at the furnaces where the air is used. For the purpose of comparison with observations of the Weather Bureau, there is shown in Table II. the average monthly content of moisture in the air at the furnaces, the observations being made at 9 a.m.

Table II.

	Grains of water per cubic foot of air.
January	2·8
February	2·7
March	3·1
April	3·3
May	4·7
June	7·3
July	7·0
August	7·1
September	5·4
October	3·2
November	2·3
December	3·0

The variations in moisture from month to month set forth clearly the conditions, as to atmosphere, with which blast furnaces in this country have had to contend. If these conditions were uniform throughout the whole month, it would not be a difficult problem to deal with; but unfortunately they are not uniform, and it is instructive to note the changes which occur from day to day in the same month. In a list of records given in the paper, but not reproduced here, is shown a record worked out from data furnished by the Pittsburg Weather Bureau. These observations were taken at 8 a.m. and 8 p.m., and show the grains of water per cubic foot of air at the time observed, for the months of January and July. In this list it was shown that, while the moisture in the atmosphere in the month of January is much less than in July, yet the percentage of variation is greater. The changes are great not only from day to day, but from hour to hour in the same day, and often they are very abrupt. How frequently has it happened in the experience of every furnace manager that the furnace has gradually or suddenly lost its hearth temperature and produced a grade of iron either undesirable or unmarketable, without any visible cause. Tuyeres are examined for leaks, the raw material in the stockyard is carefully inspected, and usually the coke is condemned. A more intimate acquaintance with the atmosphere would have provided a correct and ready reason, for the variations therein are not only many times greater than in the raw material, but a greater weight of it is used per ton of iron.

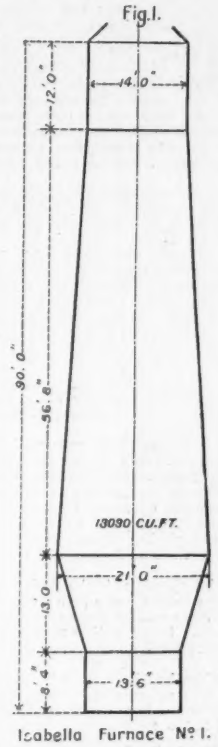
It is true that the atmosphere has been recognised by many metallurgists as the cause of many and serious irregularities in blast-furnace operations, but it is doubtful if its influence has been adequately recognised. It has often been a matter of surprise that a greater saving of fuel per ton of iron was not obtained in the winter, as compared with the summer season, as the records show a much less content of moisture in the atmosphere, the reason being that blowing engines at blast furnaces do not receive air of the dryness as shown in the above tables. In summer the windows and doors of the blowing engine room are wide open, and the supply of air, with reference to humidity, is practically that of the atmosphere; but in winter they are nearly or quite closed, and the entering air has mixed with it all of the steam that leaks from the engine and is contaminated therewith. Records taken over a number of years show that there is not a very great difference in the moisture in atmosphere between observations taken outdoors in summer and in the engine-room in winter. In Table III. are monthly records showing a comparison between winter and summer months, the observations having been taken indoors and outdoors respectively.

Table III.

Winter. Month.	Grains of water per cu ft. of air.	*Summer.* Month.	Grains of water per cu. ft. of air.
January	4·5	April	4·2
February	4·6	May	4·1
March	4·7	June	6·4
October	6·4	July	5·2
November	4·6	August	6·7
December	5·0	September	5·7

A comparison of the data given in Table III. with Table II. would suggest that a great advantage could be derived by leading pipes from outdoors to the inlet valves of the air cylinder, and it certainly appears that a material advantage could be gained. So impressed was the writer with this conclusion that the blowing engines at a furnace under his direction were so equipped in the month of January, and continued to draw the supply of air from outdoors throughout the year. The excellent results expected in the winter season did not materialise, or rather were so slight as compared with a companion furnace not so equipped as to argue against any extension along that line. This experience suggested the conclusion that while the air in the engine-room was higher in its content of moisture, through its admixture with steam, than the outside air, yet it was not subject to the same variations; and further, that these variations, which were often sudden and great, were really the most troublesome feature, and that nothing less than maintaining the atmosphere uniform with respect to humidity would prove of any material advantage.

Fig. 1.



Isabella Furnace No 1.

Various schemes for absorbing the moisture were worked out and in turn abandoned, and refrigeration by means of anhydrous ammonia was chosen. After many preliminary experiments an insulated chamber containing coils of pipe, and of sufficient size to treat the air from a blowing cylinder 3ft. in diameter, was built. A small ice machine was installed to circulate the ammonia through the coils, and the air was admitted to the refrigerating chamber from an auxiliary chamber in which steam could be introduced at will, thus making it possible to treat, at any time, air containing the maximum amount of moisture with which it would be necessary to contend in the summer months. In this experimental plant air was treated under a variety of conditions for quite a period, and from the data obtained the equipment for a modern furnace was worked out. The Isabella Furnaces of the Carnegie Steel Company, at Etna, Pa., a suburb of Pittsburg, were selected as the plant at which to install the apparatus for applying the dry-air blast. The lines and dimensions of this furnace are shown in Fig. 1, and represent the usual construction of furnaces in the Pittsburg district. The furnace is blown with twelve 6in. tuyeres, and is equipped with four hot-blast stoves. Blast is supplied by three blowing engines having the following dimensions:—Steam cylinder, 44in. diameter; air cylinder, 84in.; stroke, 60in.

The ammonia machines are of the compressor type, and were built by the York Manufacturing Company, York, Pa. The dimensions are as follows:—Diameter high-pressure steam cylinder, 28½in.; low-pressure, 56in.; compressor cylinder, 22½in.; stroke, 36in. Two compressors were installed in order to have one in reserve at all times, as a furnace operating on uniformly dry air cannot be subjected to ordinary atmospheric conditions without serious results, and frequently, on very humid days, the assistance of the second engine might be required. Each compressor has a capacity of 225 tons ice melting effect. The brine-tank coils are covered with calcium chloride brine, having a sp. gr. of 1·21. The return brine from the refrigerating chamber flows into the top of the tank, is cooled by the ammonia expanding between the outer and inner pipes, withdrawn therefrom by a pump, and forced back into the 2in. or inner pipes, where it is cooled below the freezing point, and thence into the coils in the refrigerating chamber. The ammonia enters at the bottom of the pipes, thus travelling in the opposite direction from the brine, and, by expanding between the 2in. and 3in. pipe, cools the brine both in the tank and in the inner pipes. Forty thousand gallons of brine are required in the system. In the arrangement of pipes in the refrigerating chambers there are in each vertical line of coils seventy-five 2in. pipes, 20ft. long, and in the chamber there are sixty vertical lines of coil, the whole representing 90,000 lineal feet of 2in. pipe in the chamber. The pipes in each vertical coil are placed in staggered position to ensure better contact with the air. The series of coils is divided into three sections, and fed through a 4in. header, and discharges into a 6in. header, thence into a standpipe, from which the brine flows to the brine tank, its feed being arranged to cause the brine to flow in a direction opposite to that of the air. As the space between the pipes would become gradually reduced through the accumulation of frost, which might diminish the efficiency of the blowing engine, a blower was installed to force air into the refrigerating chamber, and, in order to secure a uniform distribution of air over the coils, revolving electric fans were placed in the space underneath, so that all of the coils would frost alike. The entering air, according to its humidity, deposits the moisture in the form of water or frost on the lower pipes, and as frost only on the upper pipes, and passes from the top of the chamber to the blowing engines at a temperature of freezing, or below, and with a practically uniform content of moisture. When the pipes become covered with frost the cold brine is shut off from several vertical lines of coil at a time, and, through an auxiliary pump and line of pipe, brine that has been heated in a tank with steam is forced through, and in a few minutes the frost is melted. Connection is then made with the cold-brine system, and frost begins to deposit quickly. The frost which has been melted off the pipes collects in a trough in the basement floor, from which it flows into the supply tank for the condenser.

The dry-blast plant was put in operation on August 11th, 1904. The furnace was making a grade of iron suitable for the basic open-hearth furnace, containing less than 1 per cent. silicon, with an ore mixture consisting of 50 per cent. Mesaba ore, the balance being soft hematites from Michigan. The mixture showed a yield by analysis of 53·5 per cent. iron. The coke used was shipped from two mines, and contained on an average 10·5 per cent. and 12·5 per cent. of ash respectively, and also varied considerably in ash. In the data following a comparison is made between the operations of the furnace using dry air after August 11th and those from August 1st to 11th, when the furnace was using the atmosphere under ordinary conditions. The burden on the furnace from August 1st to 11th inclusive was as follows:—

	Lbs.
Coke	10,100
Ore	20,000
Stone	5,000

On August 11th, 5 per cent. increase in burden was put on the furnace, and later in the day 33 per cent. of dry blast was used. As soon as this small quantity was introduced its effect was noticeable by a brightening of the tuyeres and an increasing temperature of the cinder. After this change in burden had come to work and the condition of the furnace showing, if anything, more satisfactory, an additional 5 per cent. of burden was put on with confidence, feeling assured that an increased use of dry blast would offset the increased duty on the furnace. From this period on the burden and volume of dry blast were increased more slowly until, on August 25th, the furnace, using dry blast entirely, had the following burden at work:—

	Lbs.
Coke	10,200
Ore	24,000
Stone	6,000

thus in two weeks obtaining an increase in burden of 20 per cent. The record of the furnace from August 1st to 11th, prior to the use of the dry blast, and from August 25th to September 9th inclusive, using all dry blast, shows that during the first eleven days the average production per day was 358 tons, and the average coke consumption in pounds was 2147. As compared with this the sixteen days between August 25th and September 9th gave an average production of 447 tons and an average consumption of 1726 lb.

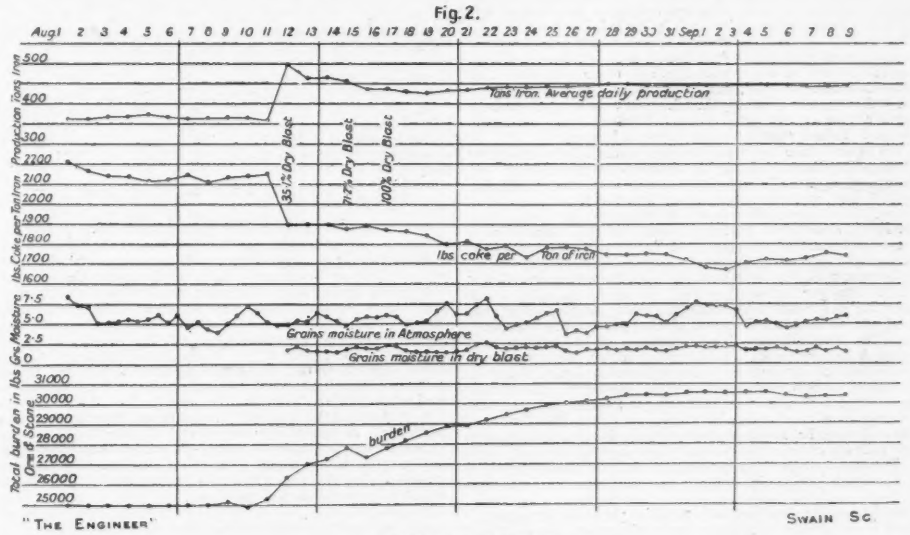
In Fig. 2 these records are set out graphically. This diagram speaks for itself, but it should be remembered that while the reduction in moisture and its increase in uniformity is considerable, this represents only the beginning of operations, and there was still much to be learned with respect to manipulation of the dry-blast plant. The effect of reducing and making more uniform the moisture in the blast was clearly shown when, during a period of excessive humidity extending over three days, a neighbouring furnace charged during this period an extra quantity of coke, and increased the quantity each day in order to maintain the grade of iron, while the Isabella furnace, operating on dry blast was in no wise affected.

On September 10th it was found necessary to make some repairs to the compressors and to make connections to a new brine-header for thawing off the coils, and the burden was lightened accordingly. After these repairs had been made the burden was again increased, and from September 17th to 30th inclusive the furnace showed an average daily output of 452 tons, with a coke consumption of 1729 lb. per ton of iron.

During a period of thirteen days the average moisture in the atmosphere was 5·66 grains per cubic feet, and in the dry air 1·75 grains. Sixty-nine pounds of water were removed from the blast per ton of iron produced, which represents an average of 23,192 lb.—equivalent to 2784 gallons—for the twenty-four hours. This weight was calculated from the volume of air blown into the furnace, as shown by piston displacement. For four days during the above period the water caught in the tank underneath the refrigerating chamber amounted to an average of 21,761 lb.—equivalent to 2588 gallons—for the twenty-four hours, which is as close an agreement as could be expected, considering that the figures do not represent the same number of days, and the difficulty in accurately determining the volume and humidity of the air supplied in a given period. It is found sufficient in practice to thaw the frost off the pipes every three days. The coils are divided, for the purpose of thawing off, into three sections, each representing the same number of coils, and a section is thawed each day, and in this way the work of refrigeration is not interfered with.

As the dry blast was supplied to the furnace it became necessary to reduce the revolutions of the blowing engines, since the air supplied to the engines was lower in temperature than with the natural atmosphere and contained more oxygen per cubic foot, and the tendency of the furnace was to drive too fast. Before applying the dry blast the engines were running at 114 revolutions and supplying 40,000 cubic feet of air per minute; the revolutions were gradually reduced to 96, thereby reducing the volume of blast over 6000 cubic feet per minute, and increasing the efficiency of the engines by 14 per cent. With dried blast, 96 revolutions per

Fig. 2.



RECORD OF RESULTS

* Iron and Steel Institute, New York Meeting.

† All tons are gross tons of 2240 lb., and all temperatures are Fahrenheit.

minute of the blowing engines burned nearly 1 per cent. more coke and produced 89 tons more pig iron in 24 hours than 114 revolutions on natural air. The reduction of the revolutions resulted in a gain of 150 degrees in temperature of the blast, which, even with this increase, through lack of area in the waste gas ports of the stove, did not average above 870 degrees. The average analysis of the gas for ten days prior to the introduction of the dry blast showed CO, 22·3 per cent.; CO_2, 13 per cent., with an average temperature of 538 degrees. Later, with dry blast used entirely, the average analysis was, CO, 19·9 per cent.; CO_2, 16 per cent., with an average temperature of 376 deg. This reduction in temperature of 162 degrees is a necessary consequence of the greater concentration of heat in the hearth by the dry blast combustion, and the greater weight of burden heated by the gas, and represents an important saving of heat in the furnace.

The use of the dry blast has resulted in economies in several other directions. With the use of Mesaba ore, which is very fine in structure, the waste of ore dust through the escaping gases is quite large, and at many furnaces the waste in ore has become quite burdensome. The waste at the Isabella furnace before dry blast was used amounted to 5 per cent. of the ore charged; this has been reduced, through the greater uniformity in the furnace working, to less than 1 per cent. The saving in coke consumption reduces the phosphorus in the metal, and this, in making Bessemer iron, permits the use of higher phosphorous ores. As the Isabella furnace was making basic iron, it was of advantage to keep the silicon as low as possible, provided the sulphur was kept low, and the absence of irregularities in the furnace operations resulting from the dry blast permitted the keeping of the silicon at a lower range without increasing the sulphur. It has been generally observed by furnace managers that when the silicon is lowered, through increased humidity in the atmosphere, a leaking tuyere, or through other causes, the sulphur is rapidly increased; but it has been found in using the dry blast, that when the hearth temperature was suddenly lowered, principally from accretions on the bosh reaching the hearth, the sulphur did not increase, and in this respect the furnace has shown a remarkable uniformity in composition of the metal produced.

The application of the dry blast to the blast furnace has shown in addition to the economies effected, that the furnace can be operated with precision; it works with greater regularity, and in consequence the product is uniform with respect to grade and composition, which makes the dry blast of particular value in the making of foundry iron, which is marketed by grade. An increase or decrease in blast temperature has a definite effect, and can be relied on to accomplish the desired result.

While the application of the dry blast to the blast furnace has effected various economies and produced a more uniform metal, its further application to the Bessemer converter would, no doubt, result in great benefit, since air is used in large quantities and the varying humidity affects the temperature of the charge, and in consequence the quality of the steel. The metal from the metal mixer is remarkably uniform, and the additional uniformity secured through the use of dry air would be of further advantage.

CLEVELAND INSTITUTION OF ENGINEERS.

The Cleveland Institution of Engineers held its fortieth annual meeting at Middlesbrough on Monday evening, the 7th inst., Mr. F. Herbert Marshall, Tees Ironworks, Middlesbrough, the retiring President, in the chair. After the routine business had been transacted, Mr. Marshall remarked that the members would all feel with the Council that the loss of the secretary, Mr. Macpherson, during the year was a serious one, but they had been fortunate in securing the services of one who had had some experience in the work as his successor.

Mr. Worth, on taking the chair, thanked the retiring President and the members for the honour, and, in his address, reviewed the advances which had been made in engineering and ironmaking since 1862, when he came into the district.

First, in regard to the blast furnace, he believed that in that year there was only one firm in Cleveland making any use of the furnace gases—Messrs. William Whitwell and Co., Thornaby Ironworks, South Stockton, who drew part of the gas off by a pipe, which dipped some distance into the materials in the furnace. The tops of the furnaces were still open. He thought that the first furnace to be covered in and fitted with the bell and hopper was at Ebbw Vale, but that came into use in Cleveland in 1864, and soon was generally adopted. At that time the height of the furnace was about 65ft., blast pressure 3 lb. to 4 lb. heated in pipe stoves to 800 deg. or 900 deg., and the average make was 220 tons per week, with a consumption of coke of from 24 cwt. to 25 cwt. per ton of iron. The engines were all non-condensing, and 60 lb. was something like the maximum pressure; the boilers were mostly of the plain cylindrical type, now obsolete, though there were some Cornish in use, and a year or two later Messrs. Whitwell put down some "elephant" boilers, then a favourite type in France.

At the present time the standard height of the Cleveland furnace was 85ft., other dimensions varying, the blast pressure 6 lb. to 7 lb., the temperature of the blast heated in fire-brick stoves to 1100 deg. up to 1400 deg., and the make of pig iron for the week ending October 15th averaged 760 tons of Cleveland iron per furnace per week. But it was evident that many were below that. Mr. Hawdon had informed him that the average of the three furnaces making Cleveland iron at Sir B. Samuelson and Co.'s Newport Ironworks, Middlesbrough, during the six months ended September 30th last was 1272 tons per furnace per week, the maximum make of one furnace for one week being 1459 tons; the consumption of coke was 22¼ cwt. to the ton of iron, but a large portion of this was retort coke. The North-Eastern Steel Company at its Acklam blast furnaces, Middlesbrough, had also gone in for large makes; it had splendid blowing engines—compound condensing, blowing from 10 lb. to 12 lb. pressure, and capable of doing up to 15 lb. The average output over six months was 1316 tons per furnace per week, and the best make of one furnace 1644 tons. At Messrs. Bell Brothers' Clarence Ironworks, Middlesbrough, during the first eight months of this year the average per furnace per week on all Cleveland stone was 1164 tons, and the best 1324 tons; on two-thirds Cleveland and one-third foreign the average was 1498 tons; and the best 1552 tons.

Two interesting developments were in progress at present—Messrs. Cochrane and Co., who were the pioneers in the district of the evaporator condenser and the water-tube boiler, were again to the fore with a blowing engine worked by blast furnace gas, and the system would have a thorough trial at the Cargo Fleet Iron Company's works. Sir B. Samuelson and Co., Newport Ironworks, Middlesbrough, had put down a Parsons turbine, driving a rotary turbine blower, which was working well, and the perfect regularity of the blast had caused a marked improvement in the working of the furnace.

Turning to the conversion of pig iron into plates, he had been informed by Mr. J. H. Harrison that the maximum make at Witton Park in 1862 was 14 tons per shift, whereas now about 160 tons of steel plates were frequently rolled per shift in one mill; but in spite of that there was not a mill in the district or in England which was doing anything like what modern machinery was capable of, and what is reported to be done in America. For one thing, British mills were far too much cramped for room, and if the mill were kept fully fed up with steel, there was not nearly enough room to put away the plates, and the arrangements for dealing with the plates after they were rolled might be described as primitive. The consumption of steam for power purposes was excessive, though much reduced within the last few years by the substitution of electric motors for the smaller engines. But the reversing mill engine would always remain a wasteful machine, owing to the variable load, and to the cooling of the cylinders in the pauses. There were four principal reasons for the excessive steam consumption of these engines as used in the North of England. First, the cylinders were not properly proportioned to the work—he had found the cylinders far too large, and the steam pipes, steam ports, and often the exhaust pipes far too small. What was the good of having 80 lb. pressure in the boilers and only 25 lb. in the cylinders? Secondly, boiler pressure was far too low—it should be 140 lb. If an engine were taken working with, say, 80 lb. pressure on a varying load, and the boiler pressure was put up to 140 lb., reducing the cylinders in proportion, without any other alteration, about 10 per cent. would be saved on the full load, while on lighter loads the saving would run up to 30 or 40 per cent., and it must be remembered that a fair proportion of the work was always done at a load far below the maximum. The third source of loss was cylinder and steam pipe condensation. He had often wondered why no one had adopted jacketed cylinders for reversing mill engines; they cost nothing extra for upkeep. Lastly, there was the question of expansion. The speaker did not think there was a really good solution of this problem; compounding had not by any means done all that was expected of it. Very probably the compound engine actually used more steam during the first few passes while the ingot or bloom was short, and in the case of a plate mill, as plates were now rolled in England, it was doubtful whether the low-pressure cylinders ever got the chance to put in much honest work, though they would, no doubt, do so when rails, angles or billets were rolled in long lengths.

But two-cylinder simple engines, and still more, three-cylinder ones, could be worked much more expansively than now if a hydraulic reversing motion with hunting gear were employed in place of the present steam and cataract motion.

Mr. Worth believed that the greatest economy possible in driving a reversing mill would be got on following lines:—A three-cylinder vertical engine with jacketed cylinders, the water condensed in the jackets being returned to the boiler with as little loss of heat as possible; steam of 140 lb. pressure, with steam pipes of ample size and thoroughly clothed, and cylinders so proportioned that when the engine was doing the utmost required of it the mean cylinder pressure was about 100 lb. Such an engine would not need more than 22 lb. of steam per horse-power per hour, so long as it was controlled by the reversing gear alone and the load did not fall below two-fifths of the maximum, working non-condensing, and about 20 lb. if condensing.

With respect to machinery used in mining, little progress had been made. The winding engine was still a very wasteful machine, and the difficulties in the way of designing an economical winding engine were even greater than those in connection with a reversing rolling mill engine, due to the immense difference between the power required to start the load and that required when the full cage was near the top. The very best winding engine gave a very inadequate return in the shape of work done for the coal burnt under the boiler.

No such difficulties, however, interfered with the design of pumping engines, their load being constant, and a high economy could be so easily obtained that there was no excuse for such wasteful ones as were frequently used. In one colliery they burnt 22 tons per twenty-four hours for work which an up-to-date engine could have done for 50 cwt.

In marine engineering rapid strides had been made. In 1862 the simple engine, with at most 40 lb. pressure, was the regular thing, coal about 3 lb. per horse-power per hour; now 200 lb. was the pressure for trade boats and 300 lb. for the Navy, with coal down to about 1·4 lb. With Mr. Mudd's five-crank engine under 1 lb. of coal per horse-power was used. Lastly came the turbine, apparently carrying all before it, although quite in its infancy.

Mr. Marshall, in proposing a vote of thanks to Mr. Worth, said they would like to have heard a great deal more from such an authority. He was not afraid to speak out. Mr. Worth had often fallen foul of the poor blast furnace manager, with his old-fashioned engine, but he was going ahead now, though probably he was very far from what he should be. With respect to turbine engines, the speaker thought there was a great future for them. He would like to hear something from Mr. Hawdon about the turbine blowing engine at Newport Ironworks. Mr. Greville Jones seconded, and the vote was carried.

Mr. Hawdon proposed, and Mr. Worth seconded, a vote of thanks to Mr. Marshall for his conduct in the chair during the last two years, and Mr. Marshall replied.

Mr. Henry Crowe, chief engineer for Messrs. Dorman, Long and Co., Middlesbrough, at the invitation of the President, gave a few remarks on the subject of his visit to the German iron and steel works. He said he had visited excellent works, and seen wonderful machinery, much ahead, in some cases, of that in this country. In Germany a great number of mills turned out 100 tons per shift, the machinery being driven solely by gas engines of 1000 to 2000 horse-power. They were almost all going in there for gas engines. If anyone went through the German works he would quickly see for himself that the English were not at the top of the tree.

Mr. Hawdon said he had lately been talking to a German gentleman who had a large number of gas engines, and he spoke highly of their economy. But his coal cost him 15s. per ton. The economy depended upon the price at which you could get your fuel.

SOCIETY OF ENGINEERS.

Between four and five hundred visitors were present at a conversazione given on Wednesday night at the Royal United Service Institution, Whitehall, to celebrate the jubilee of the Society of Engineers. Among those present were Major-General Lord Cheylesmore, Mayor of Westminister, Sir J. Thornycroft, and a large number of representatives of the Institute of Civil Engineers, the Institute of Mechanical Engineers, the Surveyors' Institute, the Sanitary Institute, the Royal Institute of British Architects, and kindred bodies. The visitors were received by Mr. D. B. Butler, the president of the Society, and Mrs. Butler, and the interesting museum was thrown open to their inspection. A lecture on "Japan and the Far East" was given by Mr. George A. Goodwin, past-president, and was illustrated by photographic lantern views. The Society is in a very prosperous condition in its jubilee year, its numerical strength being five hundred and fifty-five members and associates.

Manchester Section of the Institution of Electrical Engineers.—The opening meeting will be held at the Grand Hotel this evening, Friday, the 18th of November, at 7.30 p.m., when the chairman will deliver his address.

Transporter Bridge at Newport.—The steel wire cables and engineering work in connection with the Newport, Mon., transporter suspension bridge, which are being supplied by Messrs. W. B. Brown and Co. (Bankhall), Limited, Liverpool, will have a total weight exceeding 350 tons. The main suspension cables are sixteen in number, each having a diameter of 2⅜in., and a length of 661ft. These cables will possess a guaranteed strength exceeding 250 tons each. There are thirty-two anchoring cables of 2⅜in. diameter and 520ft. in length, having a resistance of over 270 tons for each of the sixteen cables placed at the two sides of the bridge. Both these series of cables consist of 127 wires in the section of a heavy gauge, and they are laid together in spiral form, the massive attachment sockets being of high grade cast steel. The bridge has been designed by the original inventor, M. F. Arnodin, of Rouen, assisted by Mr. R. Haynes, the borough engineer of Newport, Mr. Alfred Thorne, of Westminster, being the contractor, and it is now approaching completion. It will form an important connection with the various large works which have been developed during recent years on the side of the river opposite to Newport.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

The engineering trades continue satisfactory, and operations are being quickened at some of the works in order to try to get through contracts before Christmas. There is a fair amount of constructive work about for warehouse and works building purposes. Admiralty orders for anchors and cables are under execution, and are affording regular employment. In the general machinery trades, the Australian, Indian, and South American demand continues satisfactory, and more confidence appears to be entertained with regard to the South African position. The rolling stock makers are busy, but some heavy orders for wheels and axles are understood to have lately found their way to the Continent owing to under-quoting.

Matters continue to look up in the iron trade, and there was again a healthy tone on 'Change this week in Birmingham. The better reports from Scotland and the North of England are helping matters here, and so are the stronger advices which are coming across the Atlantic. It is hoped, if the improvement in the American iron trade continues, that the British manufacturers will be exempt from a repetition of some of the American competition which they have had lately to face. Best marked bars are quoted £8; and common unmarked £5 15s. to £6; with hoops at £6 12s. 6d. to £6 15s.

Pig iron is from 6d. to 1s. dearer than a fortnight ago, Staffordshire cinder forge being quoted up to 42s. 6d., and part-mines up to 45s. 6d., while 42s. 6d. is asked for good Northampton sorts, and 44s. 6d. for superior Derbyshire. Galvanised corrugated sheets are commanding a better price by 5s. than recently, the minimum quotation now being £10 10s. f.o.b. Liverpool for 24 gauge; black sheets are also dearer than of late. With regard to the Bloomfield Ironworks, it is announced that these will be continued for the present, but that gradually the mills and workmen will be transferred to Walsall, one reason being that coal may be mined for beneath the present premises. Gas strip is quoted £5 17s. 6d. to £6. There is a fairly good demand for steel, and manufacturers are obtaining rather better terms both for semi-finished sorts and for sections. Bessemer billets are quoted £4 2s. 6d. to £4 5s.; Siemens, £4 10s. to £4 15s.; and mild bars £6 to £6 5s.

The demand for high-speed lathes is improving. Agricultural engineers report a better call for traction engines and portables, both for home and foreign use. Plough and harrow makers speak more favourably of their position and prospects than for some time past. In some classes of the machinery trades, and also in the general hardware industries, there is a good deal of comment upon the headway which America is making in South Africa.

The experiment in university technical education at Bournbrook, which include the model mine and the power station, is being watched with interest not only in the Midlands, but also in the Colonies and in the United States. From the latter country comes news that the example of the Birmingham University is being followed at New York, for at the Columbia University they have recently decided to construct an experimental mine. A mining authority in the States has written to the secretary of the Institution of Mining Engineers concerning the experimental mine now almost completed at Birmingham. He records his interest in it, and states that he trusts that they will be able to get comparative results from the fan tests The value of the research work which can be done with the model mine, is considerable. Surprise is expressed in engineering circles that there has been no appointment to the chair of electrical engineering at the University announced yet. This model coal mine is the first of its kind in this country. Birmingham believes in doing things well, and it is acting up to its political motto of "Forward!" Some three millions of money are to be spent upon the new University in all, and the technical and scientific equipment bids fair to be quite equal to, if not superior, to that of any other country.

The Birmingham Tame and Rea District Drainage Board are arranging to borrow £19,000, being part of the £54,030 required for the construction of bacteria beds at Minworth Greaves, and for the erection of a cottage weigh-house, &c, at Saltley.

Advices from the chief Australian trade centres recently to hand report that some fair lines of business have been placed in Sydney for structural material. Some descriptions of oil are in better demand, and prices are firmer. The cement market in Melbourne is fairly steady. Business in Adelaide is reported rather slow, although the recent agricultural exhibition gave a momentar, impetus to the trades connected with that industry, dairying machinery having been somewhat largely purchased. Good rains have fallen, but the river Darling, when the mail left, was not yet navigable. The resumption of river traffic will, as usual, lead to a revival of trade activity. Bolts and nuts of Melbourne make are selling in Brisbane, and appear to give general satisfaction both as to quality and price. New Zealand advices vary considerably. Wellington, however, reports a fairly active trade, and cement is in great demand for electric tram lines, harbour extension, and other public works. The pig iron market is weaker, owing to excess of stock.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—The outlook is better in the engineering trades than it has been for some time past, and although slight reaction has taken place in pig iron there is a feeling of confidence in the future course of this market. In the engineering trades, while there still remains room for improvement, yet there is a fair amount of employment, and prospects are better forward. The American position seems to have caused considerable discussion on 'Change. Opinions were, of course, variable, and the revival of trade on the other side would prevent the dumping, which was the case last year. Meantime, owing to the activity in Cleveland warrants, holders in this district appear to have asked from 6d. to 1s. per ton more money. Whether, however, buyers are prepared to pay this advance is a moot point, there is, no doubt, considerable buying going on at late rates. This is partially confirmed by the fact that at the meeting of the Lincolnshire Pig Iron Association no official advance was declared. Quotations, delivered Manchester, are as follows:—Lancashire No. 3 foundry, 51s. 6d. to 52s. 6d.; Lincolnshire, 47s. 6d.; Derbyshire, 50s. to 51s.; Staffordshire, 49s.; Middlesbrough, open brands, 52s. 6d. to 53s.; Scotch: Gartsherrie, 55s. 3d. to 55s. 9d.; Glengarnock, 53s. 9d. to 54s.; Eglinton, 52s. 6d. to 53s.; Scotch, delivered Heysham: Gartsherrie, 53s. 3d. to 53s. 9d.; Glengarnock, 51s. 9d. to 52s.; Eglinton, 50s. 6d. to 51s. Pig iron, f.o.t. Middlesbrough, 45s. 3d.; West Coast hematite, f.o.t. Barrow, 54s. to 54s. 6d. Hematite iron has participated in the improvement. Forge iron does not seem to have changed, but remains steady. In finished iron accounts are rather variable, but, generally speaking, there has been a better demand during the past week. There is also the additional fact of a marked absence of foreign competition. Lancashire and Yorkshire bars are quoted £6 to £6 5s.; Staffordshire bars, £6 7s. 6d.; hoops, random, £6 17s. 6d. to £7 2s. 6d., with specially cut lengths 5s. extra; sheets, £7 5s., delivered Manchester. Partly manufactured material, such as German and American billets and blooms, are coming to this market, but there is no great quantity. Corrugated sheets are quoted £10 10s. to £11, delivered Liverpool; steel bars, £6 to £6 2s. 6d.; English billets, £4 7s. 6d. to £4 10s.; hoops, £7 5s.; sheets, £7 5s. to £8 7s. 6d., delivered Manchester. Boiler plates have been in a shade better demand. The continued movement in copper has caused two advances in the manufactured article during the past week. Sheets are quoted £80 to £82 per ton; copper, seamless tubes, 10d.; brass tubes, 8d.; rolled wire, 7½d.; copper wire, 9d.

There has been no material change in the position of the coal

trade. House coal is very dull, but engine slack still continues in good demand. The shipping trade is fairly good. Prices are as follows:—Best coal for domestic purposes, 13s. to 14s.; seconds, 12s. to 13s.; common, 9s. to 10s.; steam and forge coal, best, 8s. 3d. to 8s. 9d.; best engine slack, 7s. 6d. to 8s.; medium, 6s. to 6s. 9d.; common, 4s. 3d. to 5s. at the pit; screened coal delivered Manchester Ship Canal, 9s. 3d. to 9s. 9d.; and unscreened, 8s. to 9s. 2d.

Barrow.—There is more life in the hematite pig iron trade, and a freer and fuller sale of Bessemer descriptions, with the result that makers are not only disposing of all the iron they are making, but have already disposed of most of the stocks they have been holding. On the other hand, warrant stocks remain unchanged at the very low point of 12,392 tons. No transactions are noted in warrant iron during the week. Prices are steady at 53s. 6d. net cash sellers, with no buyers, and makers, while quoting 53s. 6d. net f.o.b. for mixed Bessemer numbers, have during the week quoted as high as 54s. 6d. to 55s. per ton, but no business at these figures has been reported. The fact is that several makers are better sold forward than they were. For some time past the trade which has been transacted has mainly been for prompt delivery and in very small parcels. It is a good sign when the size of the parcels is increasing and when forward sales are reported, with a general all-round better prospect. The fact is that steel makers in several departments are ordering more iron, and there is every prospect that their requirements will be increased, at any rate, after the turn of the year. There are still twenty-three furnaces in blast, with an average rate of production of 750 to 800 tons each per week.

Iron ore is in very slow demand, and business does not show any prospect of improvement. Indeed, the importation of Spanish ore in large cargoes checks the sale of native sorts, although the latter are much cheaper to buy at 8s. 6d. per ton net at mines, as compared with 12s. for Spanish sorts at West Coast ports.

There is a much better feeling in the steel trade, and rails are certainly stronger. Further orders have been booked and the mills at Barrow are now working three-quarter time. For some time past they have only been working half-time. Several new inquiries are in the market, including business from Canada, but it is not now expected that we shall be able to secure Canadian orders in competition with Canadian makers. Other foreign business is, however, in the market, and there are also some tram orders on offer for competition. Heavy rails are at 80s. per ton net f.o.b. The trade doing in ship plates is quiet, and the mills are not working more than half-time, but an improvement is expected in trade in the course of a month or two. Merchant steel is quiet.

Shipbuilders report no new orders, although it is known prospects of good business are afforded to local builders.

Gun mountings represent a brisk department, and boilermakers and ironfounders are busy.

Shipping is moderately employed. From West Coast ports last week 8090 tons of pig iron and 6270 tons of steel were shipped, making a total of 14,360 tons, in contrast with 12,343 tons in the corresponding week of last year, an increase of 2017 tons. The total for the year to date has reached 639,999 tons, in contrast with 777,691 tons in the corresponding period of last year, a decrease of 137,692 tons.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE South Yorkshire house coal trade is considerably brisker this week, and is certain to increase in activity until Christmas. Values are somewhat stiffer, and coalowners have perceptibly reduced stocks at the pits. The demand seems to be general, the metropolitan markets as well as those of the Eastern Counties ordering freely, while local requirements are also larger. It is somewhat remarkable that with all these signs of vitality the house coal trade should not be equal to what it was a year ago. Only one reason can be given, and that is the long-continued mild weather. To-day Barnsley house coal, which is the quality most used, does not fetch more than 10s. per ton at the pit. Silkstones, which are not in great supply, continue to fetch 12s. per ton for the best sorts, and 11s. per ton for seconds. Heavy deliveries of gas coal continue to be made to the corporation gas department and gas companies.

In steam coal values have rather weakened, good hards being obtainable at 8s. per ton, while seconds are on offer at lower rates. Although Lancashire, owing to the improvement in the textile trades, is ordering more freely in small fuel, other districts are having very little sent, the result being that this class of fuel is more freely brought to bank than the market requires. There is no betterment to report in coke, ordinary foundry sorts fetching no more than 8s. to 8s. 6d. per ton.

In the iron market there is some tendency toward firmness in pig iron, although quotations remain perceptibly unchanged. Manufacturers continue to restrict their orders to immediate requirements, and there is no disposition whatever to place contracts this side of 1905. Both the foreign and the home markets are dull, and little prospect of any immediate change for the better is held out anywhere. Quotations now current are:—West Coast hematites, 63s. 6d. to 65s. per ton; East Coast hematites, 58s. 6d.; Lincolnshire forge, 43s. 6d.; Lincolnshire foundry, 46s.; bar iron, £6 5s.

In the steel trade there has been some movement of late, but orders continue to be very unevenly divided, and, on the whole, trade cannot be said to be appreciably better. Manufacturers of crucible cast steel are not doing quite so well as a month or two ago, but the demand for the special steels for fast cutting tools is well maintained.

In military, marine, and railway material no orders of any consequence have been placed during the week, and the feeling of disappointment expressed with regard to certain foreign and colonial markets has not been relieved by the placing of fresh work from any of these quarters. The home market is also quiet, but there is a general impression that things cannot go worse, and that any change must be for the better.

In the lighter staple industries of the city the season demand for Christmas and the New Year continues to be fairly satisfactory, and work will be freely given up to Christmas, when it is expected, however, that the holidays will be quite as prolonged as they were last year. The condition of business, both in the heavy and light industries, is not quite so bad as it was at the end of 1903. Several of the large firms will be able to have most of their departments fully going up to Christmas, but unless fresh orders come in shortly they will be in a position to let their workers have more leisure than either employers or employed desire. In the edge tool trade much complaint is heard, both of the distant and home markets.

The question of the unemployed is causing considerable anxiety. The Corporation are finding all the work they can for those who are able and willing to accept it, but there is a reluctance to start a relief fund similar to that of last year. In the heavy departments of trade the distress is not quite so acute this season as at the corresponding period of last year, but unless fresh work comes to hand before next month is out, the New Year is certain to open badly for many workers, both in the light and heavy industries.

Mr. William Walker, Assistant Inspector of Mines for the Durham district, has been appointed his Majesty's Chief Inspector of Mines for the Yorkshire district, and will leave at once for Doncaster to take up his new duties.

NORTH OF ENGLAND.

(From our own Correspondent.)

THE most prominent feature in the iron and steel trades this week is again the gamble in Cleveland warrants, which has continued longer than most people expected, and not only that, but it is carried on with more vigour than ever, to the detriment of regular business, for only consumers will buy where necessity compels them. Traders would be glad to see the gamble at an end and prices become settled, for no one dare buy ahead when prices fluctuate so violently, and when it is impossible to form an opinion of the course of business in the early future. It is acknowledged that there is nothing in the state of trade or the outlook to account for the rise in warrants; it is purely speculative, and prices would be declining if it were not for this artificial state of the market. Ordinary traders would like to know what is to follow the close of the gamble—whether business will actually be better or the depression return. It seems to be generally thought that, while the present range of prices of Cleveland foundry pig iron may not be maintained, it is not likely that they will fall to figures as low as those ruling when the "boom" set in.

Cleveland warrants, under the influence of the operations of speculators, have this week touched a figure higher than anything reported this year, buyers offering as much as 46s. 1½d. cash at Wednesday's close, the nearest approach to that being 46s. 0½d. on the 7th. The best price of the spring upward movement was 45s. 2d. cash on April 13th, and till last week that remained the highest price of the year. London houses continue to be the chief speculators in warrants, and it is said that some of these are buying on behalf of American speculators, who have this week started a warrant market at New York, but so far their transactions have been of little import. But the "bullish" reports from the United States have had something to do with the renewed activity of speculators here. They have to confine their operations to Cleveland warrants alone, for only of them is there a stock, which renders it safe to speculate, the stock on Wednesday being 134,013 tons, whereas of Scotch iron there is a stock of no more than 9524 tons; of Middlesbrough hematite only 300 tons is held; and of West Coast hematite 12,392 tons. It would thus be useless for operators to direct their attention to these.

The stock of Cleveland pig iron held in the public warrant stores has increased very rapidly, and is likely to continue to do so for some time, because producers have been tempted to sell a large quantity of warrants, and they will have to send their iron into store, so that they may fulfil their contracts to deliver warrant iron. The smallest quantity of Cleveland iron held by Connal's during the last three years was on July 6th, when 78,013 tons was the quantity; now the quantity is 134,013 tons, showing an increase of 18,985 tons already this month. Coupled with that there is to be taken into account that shipments of pig iron from the Cleveland district are most disappointing; this is the worst November for twelve years in this respect, and only in one month this year—February—have the exports been so small. Up to Wednesday night they reached only 34,632 tons, as compared with 37,820 tons last month, and 64,180 tons in November, 1903, to 16th. But no account at all is taken of these unfavourable figures, they are practically ignored in the excitement attendant upon the gamble.

Probably induced by the activity in the warrant market and the slight improvement in the finished iron and steel industries, it is to be noted that the shares of a number of our leading iron and steel manufacturing firms have gone up in value, in some cases rather substantially, and this may be taken to indicate that investigators take a more hopeful view of the future than has been general of late.

The prices of Cleveland pig iron are not yet following warrants up very closely. For nearly a fortnight No. 3 was kept at 45s., but on Tuesday makers saw their way to advance the quotation to 45s. 3d., and on the following day to 45s. 6d., while 47s. 3d. was quoted for No. 1, and 44s. for No. 4 foundry. The lower qualities have moved very little in value, and relatively they are a good deal cheaper than No. 3. Thus, No. 4 forge can be got at 42s.; mottled at 41s.; and white at 40s. 6d.

The improvement which has to be reported in hematite iron is of another order to that in Cleveland iron. It is not speculative, but the increased business is done with consumers. Good sales have been made to consumers, more particularly in the Sheffield district, who have bought for delivery well into next year. For mixed numbers they have paid 51s. 6d. per ton, and now it is difficult to get any under that. Altogether the prospects in this branch are decidedly more encouraging than they have been. No. 4 is at 48s. 6d. Rubio ore is tending upwards in value, though freights are lower, having fallen 1½d. this week; but what has been lost in freights has been gained in the price of the ore. Spanish mineowners have taken advantage of the advance in the price of pig iron to raise the quotations for ore. Generally Rubio ore is now at 14s. 9d. per ton c.i.f. Tees, but some business has been done at 14s. 10½d. At the same time it must be reported that one lot of 10,000 tons has been sold at 14s. 6d.

Improvement continues to be reported in the finished iron and steel trades. One indication is that Messrs. Bolckow, Vaughan, and Co. have not found it necessary to stop their rail mills alternate weeks, as intended; indeed, they have been able to keep the mills going full time during the last three weeks, and will be able to continue that for other three weeks. A strike was threatened at Messrs. Dorman, Long and Co.'s Britannia Works, on the question of the week-end shifts of mill-engine and boilermen, who have heretofore gone in to light up on the Sunday night, for which they have had special pay. The men threatened to strike if the new arrangement was made, and they were to be supported by other workmen adopting a like course. The dispute has been shelved for the present, as the employers have decided to allow the men to continue working under the old arrangement pending an alteration in the conditions of working which the firm intend to introduce.

No alterations have been made this week in the quotations for manufactured iron and steel. Steel ship plates are at £5 12s. 6d.; iron ship plates, £6; steel ship angles, £5; iron ship angles, £5 15s.; iron ship rivets, £7 2s. 6d.; steel bars, £6; iron bars, £6 2s. 6d., all less 2½ per cent. f.o.t. Heavy steel rails are at £4 10s. net, and cast iron railway chairs at £3 7s. 6d. net.

Though there is no improvement in freights, and the outlook for shipping is worse, if anything, than it was, yet something better is reported by the shipbuilders. Still the increase in business is not what they expected, and it will be difficult even to cover expenses at such prices as are now obtainable for new shipping. There can be no doubt that the reduction of wages that they have claimed is absolutely necessary. It is 5 per cent. on piece and 1s. to 1s. 6d. on time rates. On Monday the employers had a conference at Newcastle with the representatives of every trade interested in the shipbuilding and engineering trades of the North-east Coast to consider the situation. Nothing definite appears to have been arrived at, and a further conference is to be held. It is thought that the notices will be extended for a month, to allow of the further consideration of the matter.

Messrs. Wm. Doxford and Sons, Pallion, have booked an order for three steamers for the Swedish ore trade for Messrs B. J. Sutherland and Co., of Newcastle, while the Sunderland Shipbuilding Company has secured the contract for a 5500-ton steamer for Messrs. Sales and Preston, of Cardiff. Messrs. Swan, Hunter and Wigham Richardson, and Messrs. J. Readhead and Sons, have also booked orders within the last few days. Messrs. Wm. Gray and Company are reported to have got the order for two steamers of 6000 tons each from Messrs. J. F. Wilson and Co., of West Hartlepool. The Amethyst, a third-class cruiser, built in the Tyne for the Admiralty, is undergoing her speed trials off that river. She is the first war vessel of her size in which turbine machinery has been adopted, and thus her trials have more than ordinary interest.

The report of the directors of Dorman, Long, and Co., Limited, Britannia and Clarence Steel Works, Middlesbrough, for the year ended September 30th, is most disappointing. With a capital of a million and a-half, their profits amounted to no more than £24,566, and they are unable to pay any dividend to the ordinary shareholders, nor do they write off anything for depreciation. The directors state that trade has been very bad, and they have also had to contend with the difficulties of bringing into operation the new machinery at the Britannia Works. At the same time the rolling mills at the Clarence Works have not given satisfaction, and it has been necessary to make certain modifications, in order to obtain the full output of which the mills are capable. They have also strengthened and improved the machinery generally at these works. These alterations at Clarence are still going on, and the mills have been closed for several months.

The directors of Thomas Allan and Sons, Bon Lea Foundry, Thornaby-on-Tees, in the year ended September 30th, made a profit of £2342, and will pay the ordinary shareholders 2½ per cent. for one year. Mr. Edwin K. Fox, of Nunthorpe, has joined the Board.

Mr. S. Ball, who for the last twelve years has been under manager of the steel rolling mills of Messrs. John Spencer and Sons, at Newburn-on-Tyne, has been appointed manager of the Leeds Forge.

Messrs. Graham, Morton and Co., engineers, &c., Hunslet, Leeds, have advised the Principal of the Armstrong College of Science, Newcastle-on-Tyne, that they offer to young men who have obtained the B.Sc. in engineering a two or three years' course in practical work in their drawing office. They will pay a small remuneration, commencing at 15s. per week first year, 20s. per week second year, and £2 per week third year, to applicants appointed to the vacancies that may from time to time occur in their works.

The demand for steam coal has slackened very considerably, and shipments have declined, this causing very irregular working at the Northumberland collieries. But deliveries of gas coals are very heavy, and there is not much on offer, so that the price of best is kept at 8s. 1½d. f.o.b. The coke trade is showing improvement, and contracts for next half-year are being made at 6d. per ton above the rate for the contracts now running. Consumers show anxiety to buy forward. Medium coke is at 14s. 3d. per ton delivered at the Middlesbrough furnaces, a rise of 3d. per ton this week, and foundry coke is 15s. 6d. to 16s. f.o.b.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE pig iron warrant market has been somewhat irregular this week. Towards the end of last week prices gave way to some extent, the reason given being that sales were being forced by speculators. At the beginning of this week there was again a strong demand for Cleveland warrants, which recovered in price. Reports from America, to the effect that prices had been advanced from 2s. to 3s. per ton, had a strengthening effect. At the same time, there is a want of confidence in the business, owing to the great expansion of speculative transactions and the limited number of warrants in circulation.

Business has been done in Cleveland warrants at 45s. 8d. to 46s. cash, and 45s. 11d. to 46s. 2d. one month. Scotch warrants are quoted 51s. 6d., and Cumberland hematite 53s. 9d. per ton, but with little or no business doing in either case.

Since last report two furnaces have been taken off hematite and put on ordinary iron, the demand for the latter being evidently on the increase owing to the activity in the warrant market.

The prices of Scotch makers' pig iron have been firm. G.M.B., No. 1, is quoted at Glasgow 53s.; No. 3, 49s.; Carnbroe, No. 1, 53s. 6d.; No. 3, 49s. 6d.; Clyde, No. 1, 56s.; No. 3, 50s. 6d.; Langloan, No. 1, 64s.; No. 3, 54s.; Gartsherrie, No. 1, 56s. 6d.; No. 3, 51s.; Summerlee, No. 1, 57s.; No. 3, 51s.; Coltness, No. 1, 63s. 6d.; No. 3, 53s. 6d.; Glengarnock, at Ardrossan, No. 1, 58s.; No. 3, 51s.; Eglinton, at Ardrossan or Troon, No. 1, 52s.; No. 3, 49s. 6d.; Dalmellington, at Ayr, No. 1, 52s.; No. 3, 49s.; Shotts, at Leith, No. 1, 58s.; No. 3, 51s.; Carron, at Grangemouth, No. 1, 57s. 6d.; No. 3, 51s. 6d. per ton.

There is so far no material improvement in the shipments of Scotch iron. The quantity despatched in the past week was 4478 tons, compared with 5076 in the corresponding week of last year. There were despatched to the United States 80 tons, South America 50, India 240, Australia 278, France 10, Italy 345, Germany 55, Holland 443, China and Japan 145, other countries 165, the coastwise shipments being 2667 tons, compared with 3720 in the corresponding week of last year.

The arrivals of Middlesbrough pigs at Grangemouth were comparatively small, amounting to 7020 tons, against 14,670 in the corresponding week, showing a decrease of 7650 tons. There is now a total decrease in these imports for the present year to date of 98,506 tons.

There is a moderate demand for Scotch hematite, which is quoted by merchants 55s. 6d. for delivery at the West of Scotland steel works.

Business in finished iron is reported quiet, some makers finding it impossible to keep their usual shifts in full operation. The inquiry for material is slow, and there is keen competition for available orders. It should be noted at the same time that manufacturers are understood to be doing their utmost to maintain prices. There is all the more necessity for this owing to the upward movement in the pig iron market.

There is not much change to note in the condition of the steel trade. Business comes to hand slowly, but it is reported that an improvement is taking place in the demand for angles. This is, no doubt, due to recent orders obtained in the shipbuilding trade. It is expected that there will ere long be a larger business in boiler plates.

A number of contracts are reported this week in various branches of the manufacturing trades, and among the shipbuilding orders noted is one given by Liverpool owners to Messrs. William Hamilton and Co., Port Glasgow, for a steamer of 7000 tons, the engines of which are to be made at Glasgow.

There has been a fair business in the coal trade. The shipments at Clyde and Firth of Forth ports have improved, but there has been a falling off to the extent of 8000 to 9000 tons at the Fifeshire ports, which has more than neutralised the increase on the West Coast. The result is that there is on the whole a decrease of 3197 tons on the aggregate clearances from the Scottish ports, compared with those of the preceding week; and the total shipments are 16,304 tons less than in the corresponding week of last year. There has in the last few days, however, been an improved demand for cargoes to the Mediterranean and the River Plate. The inland trade in coals has been quiet. The prevalence of mild weather has kept down the demand for household sorts, the prices of which have been declining. There is a fair demand for manufacturing qualities, and supplies of all kinds of coal are abundant.

The Conciliation Board of the Scottish coal trade, consisting of representatives of coalmasters and miners, has at length fixed the terms of the wages scale, and it is expected that this will be confirmed by the men, so that a lengthened period of amicable working may be anticipated. It should also be stated that a committee, consisting of five coalmasters and five representatives of the miners, has been appointed to consider what means might be adopted for preventing excessive output of coal.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

I REFERRED last week to the application being made by coalowners for a reduction of wages. This was formally brought forward on Monday at Cardiff before the Conciliation Board, Mr. Deakin representing employers, and Mr. Brace the colliers. Mr. Deakin, in making the application, cited the opinion of Sir David Dale, that the equivalent to 30 per cent. upon the standard meant that what the owners held was a figure which entitled them to a reduction that time of 10 per cent. They, therefore, now wanted the other five. The wages now were 43¾ per cent. above the standard, and they claimed to have them reduced to 38¼ per cent. above the standard.

The workmen, who had held a previous meeting of their own at

which they had discussed the case, now, by their representative, traversed the application, and held that the owners were not entitled to a reduction; that Sir David Dale's views were applicable to another matter, and had been acted upon by coal-owners to the extent warranted. At the Monday meeting, after a long discussion, both parties failed to come to an arrangement, and at the close it was decided to call in the aid of Sir Michael Hicks Beach, and submit the case to his arbitration, which will be done on Monday next.

So long as storms retard tonnage from coming in, a brisk coal trade cannot be expected. Last week, in a run through the district, congestion at railway sidings was very apparent. On the Rhymney Railway the laden wagons were fifteen deep, extending over the "Bay," and on the Cardiff and Barry evidences wear clear that colliers had been active, but shipment scant. On the Barry line Tredegar collieries were well represented, and exhibited a good class coal. Ebbw Vale Works figure largely, and their coal is in evident demand. Amongst buyers' trucks I noticed Stephenson and Clark, of the London market.

It was stated on 'Change, Cardiff, this week, that a very large order for small coal for the French State Railways had been secured by Powley, Thomas and Co. The quantity named is 375,000 tons, and the price 12·50f. to 12·87f., delivery over next three years. On several days there has been a better and more animated attendance on 'Change, and the impression is strengthened that more buoyancy of trade will soon occur. Stems to end of month are well filled, and house coal is steadily improving. Small steam has fallen off in price; Monmouthshire semi-bituminous coals are still somewhat easy, partly owing to delayed vessels. Swansea coal shipments last week were about late averages. Newport despatched over 60,000 tons to foreign destinations, and nearly 19,000 coastwise. Swansea's despatch of patent fuel last week was limited to 9000 tons. An important sale of a large anthracite colliery is announced for this week.

Latest coal prices current in Cardiff were as follows:—Best large steam coal, 13s. 3d. to 13s. 9d.—13s. 6d. is an ordinary figure; best seconds tolerably firm at 12s. 6d. to 13s.; ordinary seconds, 11s. 6d. to 12s.; drys, 11s. 9d. to 12s. 3d.; best smalls, 7s. to 7s. 6d.; best ordinaries, 6s. 3d. to 6s. 6d.; seconds, 5s. 9d. to 6s.; inferiors, including drys, from 5s. 6d. Monmouthshire: best large, 11s. 9d.; best ordinaries, 11s. 3d. to 11s. 6d.; seconds, 10s. 6d. to 10s. 9d. House coal: best households, 15s. 9d. to 16s.; best ordinaries, 13s. 6d. to 14s. 6d.; seconds, and other kinds, 10s. 6d. to 13s.; No. 3 Rhondda, 13s. to 13s. 6d.; brush, 12s. to 12s. 3d.; small, 9s. 6d. to 10s.; No. 2 Rhondda, 9s. 9d. to 10s.; through, 8s. 3d. to 8s. 6d.; small, 6s. 6d. to 6s. 9d.

Patent fuel, 12s. 6d. to 13s.; coke, 15s. to 20s. Pit wood: very strong and advancing, 19s. 6d. to 20s.; and in some cases higher figures have ruled.

Indications at Cardiff—in part on account of stormy weather, fogs rendering the Channel difficult—are of much improved trade. Swansea and Newport quotations are 19s.

Swansea coal market is steady:—Steam coals are quoted at 12s. 6d. to 13s.; seconds, 11s.; bunkers, 8s. 9d. to 9s.; small, 5s. 9d. to 6s. 9d.; No. 3 Rhondda, 13s. 3d. to 13s. 6d.; patent fuel, including tax, 11s. 9d. to 12s. The indications of the coal trade given on 'Change are of improvement, but at present prices remain: best anthracite is quoted at 20s. to 21s.; second malting, 17s.; big vein, large, 12s. to 12s. 6d.; red vein, large, 10s. to 10s. 6d.; machine made cobbles, 17s. 6d. to 18s.; Paris nuts, 18s. 6d. to 19s.; French nuts, 19s.; German nuts, 19s.; machine made large peas, 11s. to 12s.; rubbly culm, 5s. 3d. to 5s. 6d.; duff, 4s.

Collieries reported working regularly, and accumulations small.

There has been an explosion of gas coal on a Barry boat, and injury to two men; one of them striking a match when the hatch beam was removed to find a ladder. A still more serious mishap occurred this week at Maesteg, in a coal drift belonging to North Navigation. In the absence of the engineman an assistant volunteered to let the men down, but he was overpowered, and the coal train going at a great rate a number of the men jumped off, but were seriously, some fatally, injured, One man is dead, and the inquest will be held this week. The marvel is that fifty deaths were not recorded.

It was thought a short time ago that the importation of steel billets from America had ceased, though many regarded the cessation as temporary. The latter opinion is now confirmed; several cargoes have come into Newport, Swansea, and Cardiff from Philadelphia, and, in addition, increased quantities from Germany, chiefly by way of Antwerp; 2500 tons came to Newport this week. Imports of the week include pig iron from Millom, Whitehaven, and Harrington, large cargoes of ore from Bilbao to Newport, and 3000 tons for Neath and Briton Ferry.

A good deal of iron continues to be sent to Bristol from Newport. The only consignment of rails of importance has been that of 1000 tons for Buenos Ayres, despatched from Newport, Mon.

Dowlais last week was not so busy as it has been of late, though rails continue in demand, and a fair share of the bar trade is dealt with at Cyfarthfa.

On 'Change, Swansea, this week, which was well attended by visitors from London and also from the Midlands, pig iron was reported to be gaining in strength. Since last week prices have advanced, Glasgow warrants 6d., Middlesbrough 6d. to 9d.; hematites remain. In finished iron and steel an improvement was noted; price is better in tin bars, and purchases larger. Merchant bar remains, but tone better.

Latest prices:—Glasgow warrants, 51s. 6d.; Middlesbrough No. 3, 46s.; Cumberland hematite, 53s. 6d; Welsh merchant bars, £6 to £6 2s. 6d. Steel rails, heavy, £4 5s. to £4 10s; light, £5 5s. to £5 10s. Steel sheets, £7 17s. 6d. to £8; sheet iron, £7 17s. 6d. to £8 2s. 6d.; Bessemer bars, £4 2s. 6d.; Siemens, £4 5s.

The tin-plate trade maintains the satisfactory character it has shown, though occasionally delayed tonnage tells a tale, and increases stock; but mills are in good work, and prices firm; and it is expected that the shipment of the next week or two will clear away much of the accumulations. Forward business is promising. Latest prices:—Bessemer steel coke, 12s. 3d. to 12s. 6d.; Siemens coke finish, 12s. 6d. to 12s. 9d.; ternes, 22s. to 23s. 6d.; best charcoal, 13s. to 13s. 6d. Big sheets for galvanising, 6ft. × 3ft. × 30 g. per ton, £8 15s. to £8 17s. 6d.; finished black plate, £8 15s. to £8 17s. 6d.; block tin, £132 7s. 6d.; spelter, £24 12s. 6d.; lead, £13 7s. 6d.; copper, Chili bars, £66 10s. Iron ore: Rubio, 13s. 6d. The make of tin-plates last week was 68,385 boxes; shipment, 47,472 boxes; present stock, 180,297 boxes.

The Cambrian Railway management is advertising for a supply of motor vehicles for omnibus service to hold twenty passengers. This is one of the early preparations for the next season, which promises in steamers, new lines, &c., to make the North Walian routes still more attractive. Last season the Snowdonian arrangements were excellently well carried out, and the connection with London, the North, and the Midlands, and South Wales and Monmouthshire, passed without a hitch.

NOTES FROM GERMANY.

(From our own Correspondent.)

FROM week to week the same reports must be given, as no material change takes place in the various departments of the iron and steel industry. Depression is still prevailing in many trades, and forward orders generally are scarce.

In Silesia little life is stirring in the iron industry. Pig iron is being bought in rather small quantities, and for malleable iron a quiet though regular demand comes in, prices remaining the same as before. The girder trade has been showing a little more strength than formerly, partly in consequence of the Huldschinsky works joining the Steel Convention, and inquiry as well as demand have been improving upon the week; the concessions agreed to in October are no longer granted to the works. Sheets, though far from brisk, are in better request than heavy plates, and bars sell moderately well. A weak and irregular trade is done in wire.

So far as export is concerned, more favourable accounts are being received this week than last from the Rhenish-Westphalian iron-producing districts. But there is still only a moderate home demand experienced, with hardly any forward contracts offering. Makers of pig iron complain of doing but a very limited trade, and business in the manufactured iron department has been rather disappointing this week and the last, demand being slow. Plates are but weakly called for, while sheets continue in fair request; for bars and sectional iron demand continues fairly regular; and girders, too, are in comparatively good request for this time of the year.

According to the *Cologne Gazette*, negotiations have a few days ago taken place in Brussels between the Steel Convention and the Belgian and French works regarding an agreement about export in girders. The German works offered to the French a share of 9 per cent. of the total girder export. The French representatives asked 12 per cent., however, but at last agreed to accept 11¼ per cent. offered them by the Belgian and German works. The French works have to ratify this agreement, but there is no cause to doubt their doing so, and in the meantime the export price—for 1000 tons at the least—has been fixed at £45, free Antwerp.

The coal trade continues somewhat slack, and deliveries, both in Silesia and Rheinland-Wesphalia, are not what they should be at this time of the year. In Silesia the low water in many districts is having a detrimental influence on the coal trade. Austria-Hungary, generally, and Vienna in particular, are very good customers for house coal. Shipments of coal in Silesia during October of present year have been 1,525,000 tons, against 1,704,330 tons in the same month last year, and 58,650 tons per day, against 65,550 tons per day in October last. Since the beginning of present year shipments in coal amount to 14,541,530 tons, as against 14,776,260 tons in the same period the year before.

The coke market is in a satisfactory condition, production being readily consumed at fair prices, both locally and on foreign account.

Export in coal has improved in Rheinland-Westphalia, but home demand is still moderate, and the restriction of the working hours at the pits continues a necessity. A very brisk demand comes in for anthracite. The coke trade is rather less lively than might be expected at this season of the year.

According to the *Frankfort Gazette*, a union is being contemplated between the German, Belgian, and English producers of coke.

On the Austro-Hungarian iron market the tone is fairly stiff, and business transactions upon the week have been satisfactory on the whole. Girders and sectional iron sell pretty freely; the sheet trade is lively, and wire nails are well inquired for, though somewhat weak in quotations. The pig iron trade is quiet. Recently the Railway Minister has granted to the United Wagon Shops fifty-six wagons, to be delivered April, 1905; the demand in copper boiler plates for 1905 amounting to 2533 q., and worth 534,000 crowns, has been given to the firms Chaudoir and Co., Zugmayer and Sons, and Ringhofer.

The situation of the Austro-Hungarian coal industry is far from favourable, and stocks continue heavy. Only gas coal and coal for coke making meet with good request, and coke is in strong demand, consumption exceeding the daily output, and supplies, therefore, are taken from the stocks frequently.

Makers of raw and finished iron in Belgium report that trade, on the whole, is quiet, and the tendency of prices rather less firm than some time ago. Large sales have not been effected upon the week, and the demand all round is languid.

The Belgian business in coal is without alteration, and likely to remain fairly quiet, although shipments in engine fuel are pretty regular, and the demand for house coal steady, if not extensive.

From the French iron market pretty good accounts are given as regards occupation in the different departments, and the tone generally is healthy and firm.

In the French coal trade the rise in stocks of house coal is keenly felt and complained of; also engine fuel can only be sold at comparatively low prices, and concessions have to be granted wherever an order of importance is in question.

NOTES FROM SOUTH AFRICA.

(From our own Correspondent.)

JOHANNESBURG, October 24th.

THE industrial outlook is now distinctly brighter, and a revival in business is confidently anticipated. This tale has been told before, only to meet with contradiction in the events of succeeding months, but now, for the first time since the peace declaration, there appears absolutely solid ground for the prophecy. The paramount industrial force in South Africa—the gold industry of the Rand—has definitely embarked on a new career of progressive development, as the immediate result of the assured steady imported supply of satisfactory unskilled labour.

Additional confidence is created by the knowledge, based on the statistics for the past four months, that, with the increase in unskilled labour, there is steady employment afforded to an increased number of European workmen. For every ten thousand Chinamen introduced to the mines, work is provided for at least one thousand whites.

Any uncertainty that might have existed as to the success of the experiments with tube mills on the Witwatersrand has been finally cleared up by the definite announcement of policy made by Mr. R. W. Schumacher at the annual meeting of the shareholders of the Glen Deep Gold Mining Company.

Tenders have been invited by the Wernher-Beit-Eckstein combination for the delivery of thirty-three tube mills of a design specified by their consulting mechanical engineer. The tube mill is to consist of a mild steel shell ⅝in. thick, attached to cast iron ends, supported by hollow trunnions—used for feeding and discharge—and lined throughout with a thickness of 6in. of silex or other approved lining. The cylinder is to be of 5ft. 6in. internal diameter by 22ft. 0¼in. long, arranged to run at 28 revolutions per minute, and driven by means of spur gearing from a countershaft revolving at 120 revolutions per minute. A new construction of bearing for the trunnions has been adopted, so that the tube may readily be removed and replaced as necessary for repairs to lining.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market remains quiet; still a scarcity of ready tonnage. Prices unaltered. House coal unchanged. The quantity of coal shipped for the week ending November 12th was 80,857 tons—foreign, 62,071 tons; coastwise, 18,786 tons. Imports for the week ending November 15th:—Iron ore, 1840 tons; bars, &c., 2892 tons; pig iron, 650 tons; deals, 1349 loads; pitwood, 2770 loads; iron pyrites, 700 tons.

Coal—Best steam, 11s. 6d. to 11s. 9d.; seconds, 10s. 6d. to 10s. 9d.; house coal, best, 15s.; dock screenings, 6s.; colliery small, 5s. 3d. to 5s. 6d.; smiths' coal, 3s. Pig iron—Scotch warrants, 51s. 6d.; Middlesbrough, No. 3, 46s. to 46s. 1d.; Middlesbrough hematite, 53s. 6d. Iron ore—Rubio, 13s. 6d.; Tafna, 14s. 6d. Steel—Rails, heavy sections, £4 5s. to £4 10s.; light ditto, £5 5s. to £5 10s. f.o.b.; Bessemer steel tin-plate bars, £4 2s. 6d.; Siemens steel tin-plate bars, £4 5s., all delivered in the district, cash. Tin-plates—Bessemer steel, coke, 12s. 3d. to 12s. 6d.; Siemens, coke finish, 12s. 6d. to 12s. 9d. Pitwood—19s. 6d. to 20s., ex ship. London Exchange telegrams—Copper, £66 10s. to £66 15s.; Straits tin, £132 5s. to £132 10s. Freights—steady.

CATALOGUES.

BRITISH URALITE COMPANY, Limited, 50, Cannon-street, London.—This is a neat little catalogue treating upon Uralite products for electrical work.

ERNEST ZAPPERT, 27, Chancery-lane, London.—This booklet describes the Cliff automatic fire hydrant, which has already been extensively adopted in this country and America.

BRITISH WESTINGHOUSE ELECTRIC MANUFACTURING COMPANY, Limited, London. Circular B, 1071.—This booklet describes the Westinghouse type "S. B." direct-current motors, and gives all particulars as to sizes and power developed.

GRAHAM, MORTON AND CO., Limited, Leeds. Catalogue No. 940.—This book contains admirable illustrations and particulars of conveying plant for the handling of all classes of materials. A number of illustrations of the works at Leeds are also included.

JOSEPH RICHMOND AND CO., 30, Kirby-street, Hatton Garden, London.—This firm has sent us a number of illustrated circulars of machinery chiefly used by printers and bookbinders, which was shown at the recent exhibition of the Shoreditch Borough Council.

E. F. JARVIS, Middlesbrough.—This neat pamphlet is devoted to "British" water-coolers for refrigerating and condensing plants, gas engines, &c. Besides describing the systems adopted the book also contains illustrations of notable installations for various purposes, and altogether is well worth perusal.

H. I. ROBERTS, Victoria Chambers, 42, Castle-street, Liverpool.—Several sheets containing descriptions of Roberts' patent baling presses, and also giving prices. They can be used for baling jute, cotton, wool, hay, straw, hemp, and cloth, &c. They can be worked by steam, oil, or gas engine, water, electric, or manual power.

WELLMAN-SEAVER-MORGAN COMPANY, Cleveland, Ohio, U.S.A.—A brochure entitled "What we Do" is well calculated to give an idea to the reader of the scope of this company's work. A detailed list of the products is not possible in this column. They, however, may be said to include the whole of a perfectly equipped steel works.

THE PULSOMETER ENGINEERING COMPANY, Limited, Reading.—An illustrated catalogue fully describing their water-softening plants. The system employed is by treating the water with soda and lime water solutions. The only mechanical parts used in the apparatus being employed to ensure the accurate addition of these reagents, their intimate mixing, and the removal of the salts originally in solution but transformed into suspension by the action of the reagents.

TRADE AND BUSINESS ANNOUNCEMENTS.

WERNER MOTORS, Limited, inform us that the registered offices of this company have been removed from Regent-street to 45, Dean-street, W., and that its showroom and repair shop are now at the same address.

PROFESSOR HENRY ADAMS, M. Inst. C.E., has recently retired from the City of London College, where for thirty-five years he has been head of the engineering department. He is, however, still continuing his practice as a consulting engineer at 60, Queen Victoria-street, E.C., where he has had offices for the last twenty-five years.

NAVAL ENGINEER APPOINTMENTS.

THE following appointments have been made at the Admiralty:—

Engineer Captain.—G. A. Haddy, to the Indus, for Fleet Reserve.

Engineer Commanders.—H. Abbott, to the Fire Queen, additional, for the Barham; E. Cornish, to the Pembroke, for the Africa; R. S. G. Norgate, to the Indus, for charge of floating factory and for Fleet Reserve.

Engineer Lieutenants.—R. S. Pearse, to the Vivid, and J. C. Pearson, to the Fire Queen, both supernumerary; H. Toop, to the Vivid, additional, for the Aurora, on paying off; W. C. Stephens and J. J. Sargent, to the Britannia, additional, for the Highflyer; G. E. A. Crichton, to the Sphinx; L. J. Cook, to the Indus, and for charge of t.b.s. and Fleet Reserve stores; G. E. Andrew, to the Vivid, for the Chelmer; H. E. Wolfe, to the Egmont, for the Panther; W. P. Legate, to the Leander, for the Locust.

Engineer Sub-lieutenants.—F. Dean and H. V. Gand, to the Britannia, additional, for the Highflyer.

Artificer Engineer.—H. M. Rice to the Glory, supernumerary.

THE MANCHESTER ASSOCIATION OF ENGINEERS.—The third meeting of the session in connection with the Manchester Association of Engineers was held on Saturday evening, under the presidency of Mr. Alfred Saxon, when Mr. C. J. Seaman read a paper on "Riveted Joints." There was a good attendance. The speaker treated the subject almost entirely from a bridge building and tank making standpoint, circumstances having prevented him from going into the other branches of this important subject. Mr. Boswell, of Galloway's, in the discussion, gave in a concise form the method in which boiler plates should be riveted, and the best rivets to be employed in the operation. Mr. Walthew and the president also took part in the debate, after which Mr. Seaman replied.

CONTRACTS.—C. and A. Musker (1901), Limited, of Liverpool, have received the order from Messrs. F. Matcham and Co. on account of Moss Empires, Limited, for the lifting and travelling stage and hydraulic installation, electric pumps, and accumulator for the Liverpool Olympia. This is practically a repetition of the work this firm is just completing for Messrs. F. Matcham and Co. at the Manchester Hippodrome, Oxford-street.—W. H. Bailey and Co., Limited, have in hand at the present time an instrument for the Surrey Commercial Dock for recording on a monthly diagram the fluctuations of the tide levels. This instrument is fitted with Sir Wm. H. Bailey's "patented perpetual motion" mechanism for winding up the clock, by means of which the clock will be wound by the action of the tides. The same firm have also received an order for eleven perpetual recorders for winding engines being constructed by Messrs. Hick, Hargreaves and Co., Limited, for the Transvaal mines. These instruments will record in ink, upon charts of considerable scale, the number of lifts, the speed of winding in feet per second, and the depth, which is upwards of 4500ft. They are the invention of Sir William H. Bailey, and will never require winding by hand; they are automatic, as the cage in its descent lifts the clock weight.—The Hart Accumulator Company, Limited, informs us that it has secured the contract from the War-office for the supply of sixty-seven of its standard lighting type cells, having capacity of 600 ampère hours, required at Plymouth.—We are informed that the Lords of the Admiralty have awarded contracts to the United Asbestos Company, Limited, comprising orders for "Salamander" rolled cloth packings and "Victor" metallic packings, lagging materials for boilers and pipes, including "Salamander" mattresses and "Salamander" flexible millboard; "Victor" metallic joints for water-tube, &c.—The Consolidated Pneumatic Tool Company, Limited, has received a contract from the Bremer Vulcan Schiffbau und Maschinenfabrik, of Vegesack, for a complete installation comprising 117 pneumatic tools, and also a three years' contract for all of their requirements for pneumatic tools. It has also received the contract for equipping the new yards of Messrs. Wm. Beardmore and Sons, Limited, at Dalmuir, for which over 300 pneumatic tools will be required, 100 of which are to be shipped and delivered ready for use by January 1st, 1905.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, November 1st.

THE iron and steel markets of the United States have developed unexpected strength and activity. Demands are coming in from all quarters, and furnace owners and mill owners are taking business as fast as it comes. An advance has suddenly been made in pig iron on account of so many furnaces having sold more iron than they had anticipated. Heavy sales are being made east, west, and south. The sales made in this market are surprisingly large. At this writing there are inquiries in hand which will probably result in negotiations for iron to be delivered after April 1st. The reason of this activity simply is that engineering plants and other large interests having secured a large volume of work, desire to protect themselves against any fluctuations in the market by placing contracts for sufficient material to see them through with their work. There is very little iron in the hands of consumers, large or small. Those who are placing orders are insisting upon the earliest possible deliveries. The mills are also profiting by the general improvement, and some very encouraging contracts have been placed within a few days for bars, sheets, pipe work, plate iron, structural material, as well as semi-finished products. Billets have suddenly advanced for early delivery. The larger consumers of all kinds of steel will have their requirements supplied for months to come before the next advance takes place. This advance comes as a surprise to most people. Very few anticipated the sudden changes in the situation. The most experienced judgment fails to recognise the under-current which at times takes the market by surprise. It is a matter of uncertainty as to how long the present improvement will continue.

The exports of copper are phenomenal. Domestic purchases are also quite large in sympathy. The shipments last week amounted to 6983 tons, making the total for the twenty-eight days of October 23,099 tons; about 3000 tons are now engaged for shipment, which will be made this week. The copper market continues to be excited. Extreme prices are being asked, but the average business actually done is at 13⅞ for Lake, 13⅜ for electrolitic, and 12¼ for casting, which is an advance of 1 cent per pound during the month. The other metals have not participated in the improvement.

The lead market has advanced only ten to fifteen points during the past month. Spot lead is 4·40; the St. Louis market, 4·20. Spelter has advanced twenty-five to thirty points since the first of the month, closing at 5·35, and at St. Louis 5·20. Sheet zinc is in good demand at 6·40. Copper stocks in Boston, the headquarters of stock speculation in that product, are now at the highest point in the year. Copper production will be materially increased within the next six months.

NEW YORK, November 7th.

During the past week prices of pig iron advanced unexpected 25 to 50 cents per ton. Most of the larger consumers have bought all the iron they will need for the next three months. The advance named is being paid only by those who are obliged to have iron delivered within the three months named. Most of the southern furnaces are accepting business for the first quarter of next year on a basis of 12 dols. A much larger business in iron could be done at this time if furnace people would accept September prices, but in their anxiety to make a little money they have announced the advance of 25 to 50 cents, which consumers are not willing to pay. Ore has been advanced in price, coke has gone up, and this, with the anxiety of the furnace people to make a little money, has put an end for the time being to the rush of orders for next year's delivery.

In other branches of the steel industry conditions are quite favourable. A great deal of bridge material is being contracted for, and the aggregate tonnage has been heavy. It is the intention of the railroad companies to at least double the bridge building that they did this. Preparations to this end are now being made. In addition to bridge building a great deal of rolling stock will be contracted for. A good many railroad companies have wisely or unwisely deferred ordering equipment, such as cars and engines, and now the increase of traffic has necessitated the placing of orders. Reports from several car builders within a few days showed that contracts for cars have been exceptionally heavy. The locomotive builders likewise report a good many orders since September 1st. Figures of locomotive export for nine months just published show that 394 engines were exported, valued at 3,686,285 dols., against 201 engines for nine months last year, worth 2,305,192 dols., and for 1902, 276 engines, worth 2,769,034 dols. Most of these engines go to Mexico, British North America, and Japan. For the past nine months 134 went to Mexico, 117 to British North America, and 58 to Japan, against 62, 87, and 18 respectively to the same countries for nine months last year.

The exports of copper during the past week amounted to 6514 tons, and for the first four days of November 3278 tons. It is estimated that for the month of November the copper exports will amount to 28,000 tons, and that probably about as much will be exported during December. It is probable that domestic interests will take 40,000 tons this month and next, which would make a total domestic consumption of 208,000 tons for the present year, or 458,000 tons for domestic and foreign consumption. The production of copper in the United States for this year is estimated at 349,279 and imports at 79,639 tons, total 422,488 tons. Our surplus stocks at the opening of the year was 85,000 tons, which would give a total supply of 507,428 tons. This would allow a surplus stock next January of 49,428 tons.

The lead market has been very firm throughout the week; sales are being made at 4·40; spelter at 5·40; sheet zinc is in good demand at 6·40; there is a moderate buying of tin by domestic consumers, and local fluctuations are within ¼ per cent. All the indications are favourable for continued industrial activity.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

3rd November, 1904.

23,755. VIBRATING SCREENS, W. J. Bell, Glasgow.
23,756. CONSTRUCTING SHUTTLE PEGS of Looms, J. Parkington, Burnley.
23,757. COCOA and CHOCOLATE ADMIXTURE, J. Fairclough, Birmingham.
23,758. COFFEE in a COMBINED FORM, J. Fairclough, Birmingham.
23,759. TEA in a COMBINED FORM, J. Fairclough, Birmingham.
23,760. FEEDING APPLIANCES for BIRDS, A. Hateley, Birmingham.
23,761. BOTTLES and STOPPERS THEREFOR, J. Todd, London.
23,762. MACHINES for PLANING MITRES, A. Pass, Liverpool.
23,763. LOOMS for WEAVING, W. Blackburn and M. R. Knowles, Manchester.
23,764. FASTENER for WINDOW SASHES, D. Spalding, Dundee.
23,765. INSULATING MATERIAL, A. Rudenick, Hamburg, Germany.
23,766. PHOTOGRAPHIC PIGMENT PAPER, A. Höchheimer, Hamburg, Germany.
23,767. DEVICE for the FRONTS of TRAMCARS, A. Milne, Glasgow.
23,768. ELECTRO-MAGNETS, H. W. Wilson and The East Anglian Engineering Company, Limited, Stowmarket, Suffolk.
23,769. TELEPHONE SYSTEM, S. E. Barnes, Cleethorpes, Lincolnshire.
23,770. INTERNAL COMBUSTION ENGINES, A. C. Pemberton, Rickmansworth, Hertfordshire.
23,771. APPARATUS for GRINDING KNIVES, J. Nienhaus, London.
23,772. STEAM TRAPS, H. Pieron, London.
23,773. CLIPS for TRUNKS, J. and E. Bates and Sons, Limited, and A. J. Bates, Wolverhampton.
23,774. FIRE-PLACES for BACK-BURNING KILNS, T. Mills, London.
23,775. REGULATING the FLOW of GASES, C. W. Durnford, London.
23,776. PNEUMATIC TIRE PUMPS, R. Walton, jun., London.
23,777. APPLIANCE for the USE of SMOKERS, T. W. Daggett, London.
23,778. HOLDING and CARVING DEVICE, D. O. Moody, London.
23,779. TIRES for CHILDREN'S MAIL-CARTS, H. Hickey, London.
23,780. MOULDING PHONOGRAPH RECORDS, W. E. Clifton and G. L. Hogan, London.
23,781. VENTILATOR, J. S. Sweet, London.
23,782. MEANS for FETTERING ANIMALS, S. Goldberg, London.
23,783. NON-DRIP WATERPROOF CAPE, J. Jaques, London.
23,784. ELASTIC FLUID TURBINES, G. Edwards, London.
23,785. MANUFACTURE of TURBINES, W. J. A. London, London.
23,786. AIRSHIP, A. G. Fisher, London.
23,787. PRODUCTION of GAS, E. F. Griffin and F. J. Cox, London.
23,788. PNEUMATIC HORSE COLLAR, W. Ost, London.
23,789. MANUFACTURE of SURGICAL BANDAGES, M. Worsdell, Cliffe, near Selby, Yorks.
23,790. DUPLEX SAFETY AIR TUBE for PNEUMATIC TIRES. F. F. Nickolay and W. Milligan, Stowmarket.
23,791. FITTINGS for DISPLAYING GOODS, Harris and Sheldon, Limited, and J. E. Sheldon, Birmingham.
23,792. APPARATUS for MOULDING GLASS, L. L. J. Bernard, London.
23,793. BOOT TREES, W. Y. Lambert, London.
23,794. GEAR BOXES, T. B. Andreae, London.
23,795. PREVENTING the SKIDDING of WHEELS, J. E. T. Ambrose and H. E. and F. W. Prosser, Birmingham.
23,796. POWER DRIVING BELT, J., G., and L. Fuller, London.
23,797. ELECTRICAL RECORDING INSTRUMENTS, W. H. Bristol, London.
23,798. TOY TYPEWRITERS, E. Oppenheim, London.
23,799. GRINDING MACHINES, D. S. Thompson, London.
23,800. TABLE FOUNTAINS, T. Heffernan, London.
23,801. BRAKE MECHANISM for BICYCLES, C. V. Pugh and Rudge-Whitworth, Limited, London.
23,802. INHALING MASKS, H. Lewis, London.
23,803. INTERNAL COMBUSTION ENGINES, E. F. Bradley and H. Edmunds, London.
23,804. EASELS, A. R. Cobb, London.
23,805. MOTOR CAR BRAKES, C. Bowden and J. Wood, London.
23,806. SHUTTLE SPINDLES, W. R. Bell, London.
23,807. TROLLEY RESTORERS, E. L. Calahan, London.
23,808. PUSH BUTTON SWITCH, A. C. Burnett and J. Richmond, London.
23,809. SIFTING DRIED FRUIT, W. J. Pendleton and J. H. Reap, London.
23,810. ATMOSPHERIC GAS BURNERS, F. C. Tilley, London.
23,811. PLATES for ELECTRIC ACCUMULATORS, G. Schauli and G. Petrides, London.
23,812. CAR FENDERS, F. A. Dalby, E. Kniveton, and C. W. Davis, London.
23,813. CONTAINERS for CIGAR HOLDERS, J. A. Fletcher, Coventry.
23,814. PHOTOGRAPHIC STANDS or TRIPODS, A. Phalempin, London.
23,815. VEHICLE LAMPS, G. Ducellier, London.
23,816. ELECTRIC CONTROL SYSTEMS, The British Thomson-Houston Company, Limited. — (*The General Electric Company, United States.*)
23,817. ELECTRIC MOTOR CONTROL, The British Thomson-Houston Company, Limited. — (*The General Electric Company, United States.*)
23,818. MACHINE TOOLS, E. A. Carolan.—(*The General Electric Company, United States.*)
23,819. BAG FASTENERS, A. Barker, London.
23,820. ELECTRICAL CHOKE COILS, G. S. Carson, London.
23,821. LETTER-BOXES, E. M. Webb, London.
23,822. LIFTING JACKS, E. Würstner and C. Pfizenmaier, London.
23,823. ENGINES, C. Fero, sen., and F. W. Hastings, London.
23,824. MAKING CONCRETE BUILDING BLOCKS, T. Podmore, London.
23,825. DETACHABLE ROCKERS, R. L. Gay, London.
23,826. METALLURGICAL FURNACES, E. L. Davies and W. G. Clark, London.
23,827. WELDING METAL PLATES, E. L. Davies and W. G. Clark, London.
23,828. TERMINAL for ELECTRICAL APPARATUS, H. G. Prested, London.
23,829. WELDING METALS, E. L. Davies and W. G. Clark, London.
23,830. TOY, J. Bateman, London.
23,831. SECURING BAND, A. L. Weissenthanner, London.
23,832. SCOURING MUD from the BOTTOM of HARBOURS, R. C. Bullock, London.
23,833. PROPELLERS, J. M. Jones, London.
23,834. ALTERNATING CURRENT MOTORS, L. J. Hunt and the Sandycroft Foundry Company, Limited, Liverpool.
23,835. PNEUMATIC WHEELS for VEHICLES, W. Bentley, Liverpool.
23,836. SOUND-PRODUCING TOYS, F. Norris, Liverpool.
23,837. SLIDE CARRIERS for MAGIC LANTERNS, F. C. Edmonds, Lindsay, Ontario, Canada.
23,838. SCREWING MACHINES, Schaffhauser Strickmaschinen Fabrik and Schoop and Vogler, Berlin, Germany.

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23,839. CHANGE SPEED GEAR, F. W. Lanchester, Birmingham.
23,840. STEAM GENERATORS, J. M. Hurd, Stoke-on-Trent.
23,841. DISPLAYING ADVERTISEMENTS, F. P. Webster, Glasgow.
23,842. SUPPLYING AIR to FURNACES, E. C. Mills, Manchester.
23,843. INTERNAL COMBUSTION ENGINES, Mather and Platt, Limited, and A. E. L. Chorlton, Manchester.
23,844. PISTONS, Hitchon Gear and Automobile Company, Limited, and J. Weller, Accrington.
23,845. AUTOMATIC STOPPING the OVERFLOW of COAL, R. Haworth, Nelson, Lancs.
23,846. CONSTRUCTING LOOM WEFT FORKS, M. Crossdale, Burnley.
23,847. SURFACE CONDENSER, S. Quantick and C. Kerswell, Devonport.
23,848. RIM BRAKES for CYCLES, H. A. Lamplugh, Birmingham.
23,849. STEREOTYPERS' CASTING BOXES, A. J. F. Eves, London.
23,850. USING BACTERIA for FERTILISERS, J. Seaman, London.
23,851. SASH FRAME, C. Fairbank, Birmingham.
23,852. HYDRAULIC PUMPS, C. H. Parker, Wednesfield, Staffs.
23,853. CORES for VALVES, H. Creighton, Bradford, Yorks.
23,854. MINERAL WATER BOTTLES, C. M. P. H. Triscott, Dublin.
23,855. DRESS GUARDS for LADIES CYCLES, W. and P. W. Liggins, Coventry.
23,856. RAT TRAPS, T. G. F. G. McCombie and J. B. S. MacIlwaine, Monkstown, Co. Dublin.
23,857. TRAMWAY TROLLEY HEADS, S. Shepherd, jun., Sheffield.
23,858. ELASTIC TIRES, J. Birtwistle, Manchester.
23,859. FIRE-EXTINGUISHING SPRINKLERS, A. W. Storey, Manchester.
23,860. PNEUMATIC TIRES for VEHICLES, J. T. Williams, Liverpool.
23,861. DYEING of WOOLLEN GOODS, A. C. Stillie, Glasgow.
23,862. LIGHTING INCANDESCENT GAS LAMPS, W. K. Laidlaw, Glasgow.
23,863. TOBACCO PIPES, J. Millar, Glasgow.
23,864. IN-AND-OUT INDICATORS for DOORS, T. G. Hartland and H. Luke, Manchester.
23,865. IN-AND-OUT INDICATORS for DOORS, T. G. Hartland and H. Luke, Manchester.
23,866. PRESERVING MEAT, J. T. Freestone and J. A. Walker, Liverpool.
23,867. EXHAUST SILENCERS, R. H. Haylock, Liverpool.
23,868. STEEL NIB PEN CLEANER, L. I. Martendall, London.
23,869. HOPPER WAGONS, H. S. Keith and C. R. Bonn, Bowling, N.B.
23,870. GLAZING BARS for ROOF WINDOWS, E. W. Roberts, Sheffield.
23,871. AN ELECTRIC LIGHT for BUOYS, P. Watson, Grimsby.
23,872. SURVEYING APPARATUS, W. H. Lock and A. H. Pollen, London.
23,873. ATTACHING ARTICLES to the DRESS of the WEARER, L. Courlander, London.
23,874. CYCLE BRAKES, The Enfield Cycle Company, Limited, and A. T. Austin, Birmingham.
23,875. TELESCOPIC KERB FENDER, R. W. Findlay Edinburgh.
23,876. RECORDING SURFACES of TRAMWAYS, A. H. Rowan, London.
23,877. AUTOMATIC ROPE CHECK, W. H. le Maitre, London.
23,878. SHOW CASES, W. Hudson, London.
23,879. FILLING BOTTLES, G. W. Bamford and A. E. Ellen, London.
23,880. MANUFACTURING BUILDING BLOCKS, J. W. Shone, London.
23,881. SIZING APPARATUS, H. L. Sulman and H. F. Kirkpatrick-Picard, London.
23,882. METHOD of ADVERTISEMENT, W. E. Manning, London.
23,883. DOOR LOCKS, E. A. Vergar, London.
23,884. GAS ENGINES, F. O. Farwell, London.
23,885. BRAKES for RAILWAY VEHICLES, B. Braun, London.
23,886. CARBIDE RECEPTACLES for ACETYLENE GENERATORS, M. W. Holfert, London.
23,887. APPARATUS for MIXING CONCRETE, R. Ames, London.
23,888. OPTICAL LANTERNS, C. Beck, London.
23,889. VENTILATORS for BUILDINGS, F. J. Talbot, London.
23,890. MEANS for PROPELLING CYCLES, J. P. Lamb, London.
23,891. FRYING-PAN, L. G. Hartmans, London.
23,892. COOKING UTENSILS, L. G. Hartmans, London.
23,893. GUM ELASTIC and FLEXIBLE CATHETERS, M. Allen, London.
23,894. WATER TUBE BOILERS, J. Junk, London.
23,895. LIGHTING of MOTOR CARS, T. S. Suddaby, Leeds.
23,896. NEW GAME, E. J. Coppen, London.
23,897. SECURING FOLDED NEWSPAPERS, H. P. Ramsey and E. Williams, London.
23,898. SAFETY VALVES for PNEUMATIC TIRES, C. Vadon, London.
23,899. INCANDESCENT ELECTRIC LAMPS, A. Just and F. Hanaman, London.
23,900. REPRODUCTION of PICTURES, H. Bogaerts, London.
23,901. VALVES, V. F. Mortlock, London.
23,902. ELASTIC-FLUID TURBINES, J. Wilkinson, London.
23,903. GOVERNING MECHANISM for TURBINES, J. Wilkinson, London.
23,904. ELASTIC-FLUID TURBINES, J. Wilkinson, London.
23,905. GOVERNING MEANS for ELASTIC FLUID TURBINES, J. Wilkinson, London.
23,906. EXTRACTING METAL from ORE, A. Schwarz, London.
23,907. MULTIPLE-CYLINDER COMBUSTION ENGINES, A. de Dion and G. Bouton, London.
23,908. BAND BRAKES, E. F. Bradley, London.
23,909. TREATMENT of SULPHIDE, W. M. Barber.—(*G. E. Kingsley, Canada.*)
23,910. COPY-BOOK for SALESMEN, S. P. Facy, London.
23,911. PAPER CLIPS, H. R. S. Pulman and G. Higginson, London.
23,912. MOTOR CAR LAMPS, R. D. Cohen, Liverpool.

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23,913. RAILWAY CARRIAGE DOOR SPRING LOCK, A. B. Thompson, Oldham.
23,914. DYEING CLOTH, C. Beving, Manchester.
23,915. MACHINE for MANUFACTURE of WHITE LEAD, J. Scott, St. Albans, Herts.
23,916. MALT HOUSE CISTERNS, C. E. Mumford and W. Wells, London.
23,917. PUNCTURE PROOF BANDS for PNEUMATIC TIRES, A. E. Bock, Earlswood, Warwickshire.
23,918. LINEN PRESSES, J. R. Watts, Sheffield.
23,919. BOTTLE STOPPERS, A. Potts, Manchester.
23,920. TIRE DEFLATION ALARM, L. F. West, Morley, Yorks.
23,921. PNEUMATIC INNER TUBE for MOTOR CARS, L. F. West, Morley, Yorks.
23,922. ADJUSTING ARRANGEMENT for AXLE of MAIL-CART, F. G. Needham, London.
23,923. INCANDESCENT ELECTRIC LAMPS, A. W. Kenyon, Liverpool.
23,924. TREATMENT of CERTAIN WASTE WATERS, F. M. and H. Spence and P. Spence and Sons, Limited, Manchester.
23,925. PERAMBULATORS, F. W. Hosegood, Keighley Yorks.
23,926. TURBINES, A. J. Cooper, Liverpool.
23,927. STEAM TRAPS, W. H. and A. J. Bailey, Manchester.
23,928. CRANK PINS, W. H. and A. J. Bailey, Manchester.
23,929. WOOD TYPE for CYLINDER PRINTING MACHINES, R. G. Torrance, Manchester.
23,930. TOBACCO-BOX, J. Tanner and B. Highley, Abercarn, Mon.
23,931. STEAM-CONDENSING PLANT, C. Day and W. A. Dexter, Glasgow.
23,932. SUPPORTS for TROLLEY WIRES, D. M. Paton, London.
23,933. HANGING CURTAINS, W. H. Pinch and G. F. French, Manchester.
23,934. FITTINGS for CARRIAGE AMBULANCES, J. F. and A. E. Roberts, Manchester.
23,935. ANCHORS for TRAMWAY RAILS, T. I. Rudman, London.
23,936. CENTRIFUGAL MACHINES, R. Williamson and A. M. Stuart, London.
23,937. INVULNERABLE TIRE, J. J. March, Bolton.
23,938. APPARATUS for COMBINING GASES, J. Grossman, Manchester.
23,939. DRAUGHT EXCLUDERS, S. Brown, Liverpool.
23,940. WATER-CLOSET PANS, J. Merrill, Sheffield.
23,941. CENTRIFUGAL MACHINES, A. R. Robertson, Glasgow.
23,942. FILTER PRESS PLATE, C. A. Allison.—(*The Niles-Bement-Pond Company, United States.*)
23,943. THROTTLE-PIPE, K. B. F. Gremmels, London.
23,944. SO-CALLED INCANDESCENT GAS LIGHTING, G. Goldston, London.
23,945. SCALES and WEIGHING MACHINES, W. E. Hipkins, Birmingham.
23,946. GAS PENDANTS, H. W. Hanwell, Coventry.
23,947. PRINTING MACHINES, W. H. Lock and T. M. North, London.
23,948. TOY SHOOTING GALLERIES, H. Brisacher-Lonergan, London.
23,949. SPRING ATTACHMENT for SHOW-CARDS, A. F. Crofts, H. C. Smith, and G. E. Wells, London.
23,950. DYEING WOOL, W. T. and E. B. Lye, London.
23,951. FASTENING POST-OFFICE PARCEL BASKETS, G. Loverius and N. J. Stevens, London.
23,952. TELEGRAPHIC TRANSMITTING APPARATUS, J. T. Armstrong and A. Orling, London.
23,953. CULTIVATORS, E. H. Nicholson and W. Mather, London.
23,954. COMBINED MENU HOLDER and KNIFE-REST, M. Emanuel, London.
23,955. MENU HOLDER, M. Emanuel, London.
23,956. CASEMENT STAYS, Tonks, Limited, and B. Alcock, London.
23,957. CONVERTIBLE CANOPIED CHAIR, F. Pugh and A. W. George, London.
23,958. TIRE COVERS, J. Wiseman.—(*W. Crook, New Zealand.*)
23,959. DRIVING BELTS, G. Bartl, London.
23,960. NEW ILLUMINATORS, W. Goulton, London.
23,961. CHANGE-SPEED GEARING, A. J. Boult.—(*De Fries et Cie. Akt.-Ges., Germany.*)
23,962. PRIMING TUBES for PROJECTILES, R. Schlman, London.
23,963. SAFETY SUSPENDING APPARATUS, J. H. Nicholson, C. Hunter, and J. Campbell, London.
23,964. BEATER PLATES for THRASHING MACHINES, A. M. Brown and W. Foster and Co., Limited, London.
23,965. VALVES for STEAM ENGINES, F. E. Musgrave, London.
23,966. SUPPORTING and HOLDING RAILWAY RAILS, H. Livesey, London.
23,967. MOTOR TRACTORS and CARS, W. H. Carmont, London.
23,968. UMBRELLAS, W. Hookway, London.
23,969. ELECTRIC ARC LAMP, H. Diamant and A. Chiesa, London.
23,970. BONNETS for ENGINES of MOTOR CARS, R. Williams-Ellis and H. W. Robinson, London.
23,971. ELECTRIC DEVICE for CIRCUIT CLOSING, G. L. Anders and M. Byng, London.
23,972. ELECTRICAL INDICATING INSTRUMENTS, Siemens Bros and Co., Limited.—(*Siemens and Halske Akt.-Ges., Germany.*)
23,973. EXPLOSIVES, J. C. Mitchell, London.
23,974. MANUFACTURE of ACID ETHERS, C. D. Abel — (*Act.-Ges. für Anilin Fabrikation, Germany.*)
23,975. MANUFACTURE of RAZOR BLADES, C. Hammerstein, London.
23,976. MECHANICAL LEAF TURNERS, L. B. Horrocks. —(*R. Chambers, New Zealand.*)
23,977. SPRING CLIP, F. W. Powell, London.
23,978. CONTAINERS for PEPPER, A. Stevenson and F. L. Impey, Liverpool.
23,979. VALVES, C. A. Parsons and J. Turnbull, London.
23,980. ROTARY ENGINES, C. MacArthur and F. Smith, London.
23,981. FILE-BOXES for LETTERS, E. Wiedenhöff, London.
23,982. LAY FIGURES, J. F. Gems, London.
23,983. APPARATUS for CONTINUOUS DISTILLATION, E. Ray, London.
23,984. EXTRACTION of AMMONIA from DISTILLATION GAS, R. Brunck, London.
23,985. HINGES, P. and R. Grünwald, London.
23,986. COMPRESSED GUN-COTTON, J. A. Carter and The New Explosives Company, Limited, London.
23,987. SASH STOPS, W. Weeks, London.
23,988. PACKING DEVICES for PISTON SLIDE VALVES, W. Schmidt, London.
23,989. SUPERHEATERS for STEAM BOILERS, W. Schmidt, London.
23,990. STARTING INTERNAL COMBUSTION ENGINES, C. A. Jensen.—(*The Freiherr (Baron) Carl Alfred von Eoden-Fraunhofen, Germany.*)

7th November, 1904.

23,991. MEASURING INSTRUMENTS, Allgemeine Elektricitäts Ges., London.
23,992. WATER HEATER, T. Cudlipp, London.
23,993. MEANS for PREVENTING SIDE-SLIP, T. Sullivan, London.
23,994. DETACHING HORSES from VEHICLES, T. Sullivan, London.
23,995. CONTROLLING the SPEED of PISTONS, A. F. Petch, London.
23,996. PUZZLE, M. E. Blackwood, Birmingham.
23,997. MENU CARDS, C. N. Wilson, London.
23,998. VEHICLE WHEELS, H. Wilcocks and J. M. Newton, Manchester.
23,999. DRILLING CRAMP, W. Kemmish, jun., Southampton.
24,000. ENVELOPE, L. M. Swifte and A. C. Moloney, Dundrum, Co. Dublin.
24,001. TICKET-PUNCHING MACHINE, D. Maxwell, Dundee.
24,002. FASTENER, P. O'Donnell, London.
24,003. OIL LAMPS, T. S. Tarling, London.
24,004. NON-SLIPPING BOOTS, A. Harper, Stoke-on-Trent.
24,005. OPERATING GEAR of MUD GRABS, E. H. Marshall, Stockton-on-Tees.
24,006. BUTTONS, E. Box, Bexley Heath, Kent.
24,007. HANDLES for TABLE KNIVES, W. B. Hatfield, Sheffield.
24,008. LIQUID for CLEANSING PURPOSES, R. E. Evans, Stratford-on-Avon.
24,009. OPERATING EXHAUST VALVES, R. Kendal, Darlington.
24,010. CLOTH-TESTING APPARATUS, J. H. Heal, Halifax.
24,011. SCREW STOPPERS for BOTTLES, C. M. P. H. Triscott, Dublin.
24,012. LOOMS for WEAVING TEXTILE FABRICS, J. Miller, Dundee.
24,013. SPEED-REGULATING INSTRUMENTS, L. Nissim, Southend-on-Sea.
24,014. RECOVERY of MINERAL ACIDS, A. F. Taylor, London.
24,015. DISINFECTING POWDERS, The Scottish Peat Industries, Limited, and J. Meikle, London.
24,016. FIRE-GRATES, S. S. Pearce, London.
24,017. CALLIPERS, S. A., G. O. H., E. H., and A. Horstmann and W. T. Edgar, Bath.
24,018. FRAMES for MINIATURE PHOTOGRAPHS or PICTURES, J. Keiller and Son, Limited, and J. K. Greig, Dundee.

24,019. Outer Covers of Pneumatic Tires, F. Pogson, Gorton, Lancs.
24,020. Outer Covers of Pneumatic Tires, F. Pogson, Gorton, Lancs.
24,021. Collars of Ladies' Dresses, A. Archer, Liverpool.
24,022. Recording Instruments, K. Edgcumbe and E. I. Everett, London.
24,023. Manufacture of Soap, A. E. Boardman, Warrington, Lancs.
24,024. Smoke-consuming Device, H. Kleinschmidt, London.
24,025. Combined Seat-post and Saddle Bracket Adjusting Device, W. J. Symons and S. Johnson, London.
24,026. Indian Curry, G. Shah, London.
24,027. Raising Theatrical Scenery, I. N. Lyons, London.
24,028. Boundary Stones or Posts, L. Weilandt, London.
24,029. Jacquard Cards, O. F. Dietzsch, London.
24,030. Electric Time-switch, F. W. E. Jones, Leamington.
24,031. Shirts and Loose Cuffs, A. J. Murphy, London.
24,032. Saddles for Velocipedes, J. W. Richardson, Londo...
24,033. Moistening or Washing Gases, P. Kestner, London.
24,034. Cannon for Acrobatic Purposes, A. J. Crosse, London.
24,035. Rotary Engine and Pump, H. J. Pocock, London.
24,036. Cameras, E. S. Hunter and W. E. Hanchard, London.
24,037. Manufacturing Chains, H. Worsdell, Cliffe, near Selby, Yorks.
24,038. Kilns, V. M. Crawford, London.
24,039. Ball and Socket Joints, V. M. Crawford, London.
24,040. Treatment of Peat or Fuel, V. M. Crawford, London.
24,041. Disintegrators, V. M. Crawford, London.
24,042. Hot Presses for Bricquetting, V. M. Crawford, London.
24,043. Bicycle Stands, W. B. Lake and E. F. Elliott, London.
24,044. Draught-proof Slip for Screens, C. Ehrhard, London.
24,045. Producing Dyestuffs, H. E. Newton.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
24,046. Non-refillable Bottles, J. U. Wilkinson, Bromley, Kent.
24,047. Regulating Bunsen Burners, J. Warry and P. Wigley, Birmingham.
24,048. Appliance for Striking Matches, J. E. Holdsworth, London.
24,049. Improved Cream Separator, C. H. Clark, Liverpool.
24,050. Halter for Cattle, C. H. Clark, Liverpool.
24,051. Circular Duplicators, J. Ellam, London.
24,052. Cleaning Ships' Hulls, T. L. Bainbridge, London.
24,053. Apparatus for Drying Hair, C. F. D. Beyer, London.
24,054. No application for this number.
24,055. Projectiles, Cammell, Laird and Co., Limited, J. E. Fletcher, and L. Burrows, London.
24,056. An Extending Round Table, G. J. Kraemer, London.
24,057. Furniture Castors, S. Phillips, London.
24,058. Frame for Picture Postcards, S. W. Abbott, London.
24,059. Motor Road Vehicles, T. B. Browne, London.
24,060. Toothbrushes, F. Lossaw, London.
24,061. Cover for Mouthpieces of Pipes, H. G. Harris, London.
24,062. Angular Chain Belt, G. Fouillaron, London.
24,063. Cleaning the Interior of Casks, J. H. Workman, London.
24,064. Gas Burners, A. W. Onslow, London.
24,065. Electric Switches, L. Thurnauer and A. D'Oreli, London.
24,066. Spittoons, T. Bass and T. E. Crocker, London.
24,067. Revolving Rooms, W. K.-L. Dickson and E. Lauste, London.
24,068. Billiard Tables, G. A. Elliss and P. J. McGuire, London.
24,069. Saturating Liquids with Carbonic Acid, J. Bienz, London.
24,070. Belt Fasteners, G. Banzhaf, London.
24,071. Locomotive Cut-off Valves, W. A. Engle, London.
24,072. Chains, W. H. Crosby and C. A. Mann, London.
24,073. Carrying Machine Guns, W. S. Simpson, London.
24,074. Shears or Tree Pruners, W. S. Simpson, London.
24,075. Internal Combustion Engines, A. G. Melhuish, London.
24,076. Driving Belts, H. Moya, London.
24,077. Aerating Grain, C. F. Hurst and C. H. Griffiths, London.
24,078. Electric Conductors, Société Industrielle des Telephones, London.
24,079. Closing Device for Bottles, W. C. A. Ortmann and the Akt.-Ges. für Glasindustrie vorm. Friedr. Siemens, London.
24,080. Knitting Machines, W. Spiers, London.
24,081. Knitting Machines, C. and E. Terrot and A. Freund, London.
24,082. Manufacture of Steel, T. J. Tresidder, London.
24,083. Production of Acetylated Cellulose, J. Y. Johnson.—(*Badische Anilin and Soda Fabrik, Germany.*)
24,084. Boots, J. Y. Johnson.—(*La Soc. D. Schneider and Co., France.*)
24,085. Machines for Printing Addresses, Addressograph, Limited.—(*The Addressograph Company, United States.*)
24,086. Fastening for Leggings and Boots, W. Cotton, London.
24,087. Moulding Machines, F. W. Hall, London.
24,088. Sealing Devices for Bottles, W. E. Heath and W. H. Sadler, London.
24,089. Electric Motors, J. S. Raworth, London.
24,090. Stand for Bicycles, G. H. de la Pleigniere and J. H. Volk, London.
24,091. Combined Tire Inflator and Life Preserver, E. H. Clements, London.
24,092. Apparatus for Recording Cricket Scores, G. E. Gordon, London.
24,093. Receiver for Wireless Telegraphy, J. G. Balsillie, London.
24,094. Automatic Changeable Leather Heels, J. H. Welsenaar and L. F. Keyser, London.
24,095. Flood Gates, F. J. M. M. Ducastel, London.
24,096. Fire-bars for Furnaces, G. A. Newton, Liverpool.
24,097. Devices for Locking Gates, E. A. Stanley and J. E. Anger, Liverpool.
24,098. Machines for Folding Serviettes, E. L. Collon, London.
24,099. Apparatus for Scrubbing Floors, J. E. Gee, London.

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24,100. Recovery of Glycerine from Spent Soap Lye, W. E. Garrigues, London.
24,101. Automatic Machinery for Winding Wires, A. D. Barty, Prescot, Lancs.
24,102. Mountings for Electrical Conductors, The Phœnix Dynamo Manufacturing Company, Limited, W. Oelschläger, and F. Haddock, London.
24,103. Carburetter for Petrol, E. Tucker and A. F. Gunstone, Bath.
24,104. Actuating Motor Horns, H. Egg and R. G. Fletcher, London.
24,105. Vulcanisers, J. B. Livesey, Halifax.
24,106. Forming Undercut Grooves in Wood, A. E. Settle, Manchester.
24,107. Oil Drums, J. G. Carrick, Glasgow.
24,108. Maintaining More Uniform Speed in Motor Cars, A. E. Beck, Earlswood, Warwickshire.
24,109. Fastening Revolving Heel Pads, C. B. Winzer, Hull.
24,110. Winding Machines, J. S. Ainley and E. Sykes, Huddersfield.
24,111. Window Fasteners, E. G. Harcourt, London.
24,112. Terrazzo Coping, A. Wilson, Glasgow.
24,113 Bottle Sealing Arrangement, G. H. Hancock, Glasgow.
24,114. Hooks, E. Evans, Birmingham.
24,115. Multi-colour Printing, F. H. Mowbray, London.
24,116. Hygienic Boot Rest, R. H. Holt, Altrincham, Cheshire.
24,117. Steam Engines, J. S., R. T., and G. N. Vaux, Sunderland.
24,118. Glands of Pumping Engines, F. Blackith, Stockton-on-Tees.
24,119. Traction Engines, J. E. Wallis, Basingstoke, Hants.
24,120. Machines for Tapping Nuts, H. Bilgram, London.
24,121. Self-lubricating Push Board, J. Phillipps, Nottingham.
24,122. Looms for Weaving, J. Haslam and Co., Limited, and C. Marshall, Manchester.
24,123. Centrifugal Machines, J. W. Macfarlane, Glasgow.
24,124. Turning Pages of Books, P. and V. Robinson, Dundee.
24,125. Conical Friction Clutches, R. Lindsay, Dundee.
24,126. Starting Engines, A. B. Brown, Glasgow.
24,127. Brackets for Windows, W. L. Hamilton, Glasgow.
24,128. Gear for Drop Stamp Hammers, J. E. Rogers, Smethwick, near Birmingham.
24,129. Penholder, T. W. and F. M. Madsen, Stockport, near Manchester.
24,130. Pneumatic Tires, T. Geddes, London.
24,131. Preparation for Illuminating Purposes, M. E. Vinten, London.
24,132. Trousers Stretchers, J. W. Radford and M. Masters, Nottingham.
24,133. Pillow Cases, A. L. Ireland, Belfast.
24,134. Hat Covering for Motoring, P. H. Davy, London.
24,135. Clutches for Conveying Rotary Motions, D. T. Powell, London.
24,136. Reduction of Sulphide Ores, H. R. Angel, London.
24,137. Gas and Liquid Valves, H. Rennie, London.
24,138. Fuse Boxes, W. T. Le Feuvre and F. A. Greene, London.
24,139. Firelighters, P. Vogel, London.
24,140. Diaphragms for Phonographs, E. Edwards, London.
24,141. Gear for Driving Centrifugals, F. Hugershoff, London.
24,142. Electric Interrupters for High-frequency Currents, G. E. Johnson, London.
24,143. Liquid Dispensing Apparatus, F. G. Kammerer, London.
24,144. Automatic Couplings, Fried. Krupp Akt.-Ges., London.
24,145. Thermometers, B. F. Wickens, Ilford, Essex.
24,146. Point Apparatus for Tramway Rails, A. W. Kiddie, London.
24,147. Applying Liquid to Vehicle Wheels, A. W. Kiddie, London.
24,148. Direct Drive on Motor Cars, A. J. Berry, Reading.
24,149. Apparatus for Swing Doors, A. Cowings, London.
24,150. Cuff Links, J. H. Murray, London.
24,151. Coffee Packages, W. B. Tremaine, London.
24,152. Supporting Pottery Ware in Kilns, W. H. Turner, London.
24,153. Potato Planting Machines, J. Kennell and T. Hunt, London.
24,154. Couplings for Railway Vehicles, J. T. Jepson, London.
24,155. Force Pumps, S. B. Bamford, London.
24,156. Treatment of Galvanisers' Waste, G. E. and A. R. Davis, London.
24,157. Oil Lamps, H. Harsant, London.
24,158. Holder for Sanitary Towels, J. H. B. Dawson, London.
24,159. Moulds of Metal Trunks, J. T. Mossford, Liverpool.
24,160. Explosive Engines, J. S. Losch, Liverpool.
24,161. Heaters, W. Richter, London.
24,162. Preventing Corrosion of Bolts, C. F. Dixon-Johnson, London.
24,163. Explosion Engines, R. Miller, London.
24,164. Explosion Motors, H. H. Lake.—(*Société de Camions Automobiles Moteurs Du jour, Switzerland.*)
24,165. Automatic Fire Alarms, J. W. Griffin, London.
24,166. Electric Accumulators, F. Mouterde, London.
24,167. Ball Bearing, I. Hult, London.
24,168. Carburetters, H. H. Lake.—(*Olds Motor Works, United States.*)
24,169. Tire for Road Vehicles, W. E. Carmont, London.
24,170. Cleaning Boilers, A. B. Raymer, London.
24,171. Chairs, W. H. Dunk, London.
24,172. Gas Engines for Motor Cars, J. Tylor and Sons, Limited, and A. P. Donnison, London.
24,173. Forming Coating on Paper for Producing Sounds Phonographically, E. J. B. Brocherioux, P. J. Tochon, A. Fortier, and L. V. Marotte, London.
24,174. Separating Arsenic from Liquid Food, O. G., C. L. J. Overbeck, London.
24,175. Nickel Steel, A. de Dion and G. Bouton, London.
24,176. Carburetters, A. de Dion and G. Bouton, London.
24,177. Thermo-electric Batteries, J. Y. Johnson.—(*A. Wolf, jun., and Co., Germany.*)
24,178 Thermo-electric Batteries, J. Y. Johnson.—(*A. Wolf, jun., and Co., Germany.*)
24,179. Fermentation of Tea Leaf, J. Y. Johnson.—(*A. A. W. Jones, India.*)
24,180. Electric Transmission Systems, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,181. Systems of Electric Distribution, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,182. Hot Air Bathing Device, G. Kuntze, London.
24,183. Photographic Cameras, A. J. Boult.—(*A. Perlich, Germany.*)
24,184. Cranes, J. E. Muth, London.
24,185. Rulers and Blotting Pads, A. J. Boult.—(*H. Frey, Germany.*)
24,186. Shoulder Protectors, F. G. Sage, London.
24,187. X-ray Shield, C. W. Maunsell and F. R. Butt, London.
24,188. Treatment of Disease, M. C. A. C. Kroeger, London.
24,189. Saddles for Motor Cycles, J. Friedenstein.—(*J. Windmüller, Germany.*)
24,190. Alternating-current Motors, V. A. Fynn, London.
24,191. Sewing Needles, P. Schmitt, London.
24,192. Electric Telegraphy, S. G. Brown, London.
24,193. Means for Transmitting Motion, E. T. Pollard, London.
24,194. Coffee-pots and Tea-kettles, L. Coubeaux and E. Sarot, London.
24,195. Cold Storage Warehouses, G. C. Marks.—(*J. Wills, United States.*)
24,196. Lighting Lamps, J. Anderson and J. H. Bennet, London.
24,197. Governing Pressure of Gas, J. Anderson and J. H. Bennet, London.
24,198. Sulphides of Arsenic, F. Howles and I. S. and I. McDougall, London.
24,199. Disintegrating Kaolinic Stone, R. Frugier, London.
24,200. Electric Switches, P. L. Clark, London.
24,201. Engine Valves, O. W. Young, London.

9th November, 1904.

24,202. Drop Tube Heater, T. Tayler, Harborne, Staffs.
24,203. Window Sash Stop, J. W. Chalmers and E. M. Small, Gillingham, Kent.
24,204. Kitchen Grates, J. W. Seckerson, Dudley.
24,205. Wheels, C. W. Pradeau, London.
24,206. Teapots, J. Carr, London.
24,207. Process of Dyeing Cotton, F. E. Robertson, London.
24,208. Steam Generator, J. C. Roberts, Bridlington, Yorks.
24,209. Window Blind Rack Pulley, T. Robertson, Glasgow.
24,210. Sealing Packets, J. J. Bell, G. Heaton, and B. Alexander, London.
24,211. Weaving Velvets, R. H. and W. H. Shiers and W. Gillespie, Manchester.
24,212. Vehicle Axles and Axle-boxes, H. E. Lord, Manchester.
24,213. Tires, A. Parker, Manchester.
24,214. Vehicles and Wheels therefor, G. A. Layton, London.
24,215. Blind-stitch Sewing Machines, D. Flanagan, Manchester.
24,216. Apparatus for Locking and Releasing Railway Carriage Doors, F. Challenor and J. Pilling, Manchester.
24,217. Draught Excluders for Doors, W. H. Freemantle, Southampton.
24,218. Distributing Liquid to Filter Beds, S. H. Adams, Scotswood-on-Tyne.
24,219. Hinges and Sash Fasteners, R. C. Ross, Dundee.
24,220. Pegs for Picketing Horses, W. J. Bosley, Southampton.
24,221. Stays for Steam Boilers, W. M. Bocquet, Redcar, Yorks.
24,222. Washing Machines, D. K. Tullis, Glasgow.
24,223. Blasting Compounds, A. F. Hargreaves and Curtis and Harvey, Limited, London.
24,224. Combing Machine, H. Colburn, Keighley, Yorks.
24,225. Wheel Guards for Tramcars, E. Nicholson, Carlisle.
24,226. Shop Fittings, Harris and Sheldon, Limited, and J. E. Sheldon, Birmingham.
24,227. Anti-skidding Device for Wheels, B. Rose, Birmingham.
24,228. Two-speed Cycle Gear, The Raglan Cycle and Anti-Friction Ball Company, Limited, and G. Taylor, Birmingham.
24,229. Tool Guards, T. F. Miller and F. Napper, London.
24,230. Construction of Pickers used in Weaving, Fleming, Birkby, and Goodall, Limited, and H. Lumb, Halifax.
24,231. Furnaces, M. Harvey and W. C. Wilson, Birmingham.
24,232. Method of Melting Pig Iron, Bayliss, Jones and Bayliss, Limited, and G. Milner, Wolverhampton.
24,233. Steam Turbine Wheels, C. A. Allison.—(*The Hooven, Owens, Rentschler Company, United States.*)
24,234. Hermetic Joints, La Société Le Goupil père et fils, London.
24,235. New Method of Photography, S. H. Crocker, London.
24,236. India-rubber Pads for Boots, J. Robins, London.
24,237. High-speed Engine, H. Le Jeune, Upper Parkstone, Dorset.
24,238. Making White Lead, G. Heyl and Co. G. m. b. H. and A. Wultze, London.
24,239. Advertising Means, W. J. Hawkins, Manchester.
24,240. Slides and Buckles for Belts, W. W. Twigg, London.
24,241. Means for Reversing Seats, G. Bown, Newport, Mon.
24,242. Gas for Heating Purposes, A. H. Arzt and S. Baron, London.
24,243. Mechanism for Motor Vehicles, C. H. Wynn and C. A. Hamilton, Coventry.
24,244. Press-cutting Knives, H. H. Freer and W. A. North, London.
24,245. Leggings, J. W. Archer and G. T. Twigger, London.
24,246. Photographic Printing Frames, Kodak, Limited.—(*J. S. Cummings, United States.*)
24,247. Photographic Printing Frames, Kodak, Limited.—(*F. A. Brownell, United States.*)
24,248. Incandescent Light Mantles, A. Winkler, London.
24,249. Weirs, R. Krause and C. Bernard, London.
24,250. Screw-taps, H. Ahrens, London.
24,251. Driving Gear, J. Nuttall, G. Bentley, and A. A. Whitley, London.
24,252. Crossing for Railway Lines, A. Ludolphy, London.
24,253. Tobacco Pipes, G. Grice, Birmingham.
24,254. Printing Machines, T. A. Nelson and J. Murray, London.
24,255. Pneumatic Tires, W. and G. E. Jenkinson, J. W. Squier, and H. E. Smith, London.

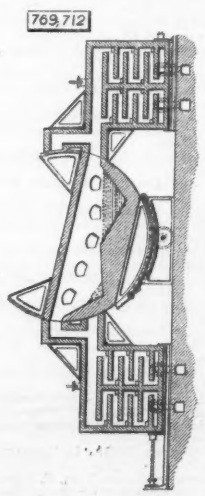
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

769,712. Tilting Metallurgical Furnace, *J. A. Potter, Pittsburg Pa.—Filed December 26th, 1903.*

Claim.—(1) An endwise tilting furnace having end ports, regenerators located at its opposite ends, and

769,712

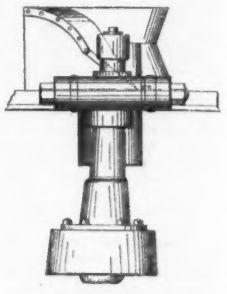


having ports arranged to register with the furnace ports, said regenerators being movable in the line of the longitudinal axis of the furnace, and means for moving the regenerators in such line toward and from the furnace, substantially as described. (2) An endwise tilting furnace, movable regenerators located at opposite ends of the furnace, and having ports arranged to register with its end ports, and arranged with a space below one end of the furnace to admit a receptacle, and means for tilting the furnace below the ports to pour at least a part of the bath from the end port of the furnace into the receptacle, substantially as described.

769,740. Crushing or Pulverising Mill, *E. C. Griffin, Newton, Mass.—Filed February 18th, 1904.*

Claim.—In a mill of the class described, a grinding chamber containing an annular die, an overhead revoluble carrier, a crushing roll, a supporting spindle therefor depending from and mounted to swing on the carrier, a tubular shield mounted on and depending from the carrier and surrounding the spindle, the lower end of the shield opening into the grinding

769,740

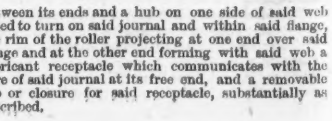


chamber, and a hood mounted on the carrier and having a contracted outlet end communicating with the upper end of the shield, the enlarged inlet end or mouth of the hood being turned in the direction of rotation of the carrier, whereby a blast or current of air is collected by the hood and rapidly forced down through the shield into the grinding chamber.

769,762. Means for Staying Plates, *J. M. McClellon, Everett, Mass.—Filed May 21st, 1904.*

Claim.—(1) A means for staying sheets or plates, comprising a plurality of parallel ribs extending perpendicularly from one sheet and integral there-

769,762

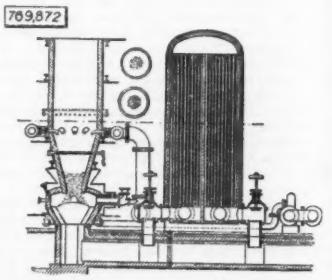


with, and means to connect said ribs to the other sheet. (2) In boiler construction, two sheets forming between them a steam or water space, and a plurality of parallel ribs connecting said sheets and integral with one of them.

769,872. Shaft Furnace for the Combustion or Destruction of Refuse, *H. Ochsenius, Berlin, Germany.—Filed March 16th, 1901.*

Claim.—(1) In combination a furnace having a combustion chamber, said chamber having a support therein and a lower outlet for the products of combustion, and having also a shaft or stack above the combustion chamber, means for introducing heated air to the combustion chamber at the upper surface of the support, and means for introducing heated air to the stack to subject the material to a preliminary heating before it reaches the combustion chamber,

769,872

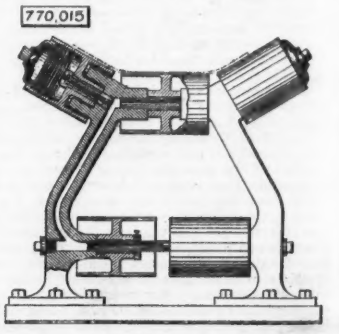


substantially as described. (2) In a furnace a combustion chamber, an outlet for the products of combustion below the same, an air heater, means of communication between said air heater and the said outlet whereby the air heater is heated from the products of combustion, means for cutting off the communication between the air heater and outlet, a stack in the furnace above the combustion chamber, and nozzles connected with the air heater and directed into the combustion chamber and stack respectively, substantially as described.

770,015. Conveyer Rollers, *F. N. Merrill, Belgium, Wis.—Filed October 23rd, 1903.*

Claim.—The combination of a stand having a tubular journal with a lateral opening through it and an annular flange concentric with and surrounding one end of the journal, a hollow roller having a closed web

770,015



between its ends and a hub on one side of said web fitted to turn on said journal and within said flange, the rim of the roller projecting at one end over said flange and at the other end forming with said web a lubricant receptacle which communicates with the bore of said journal at its free end, and a removable cap or closure for said receptacle, substantially as described.

RECENT LOCOMOTIVE WORK ON THE LONDON AND NORTH-WESTERN RAILWAY.

By Charles Rous-Marten.

No. II.*

Having set forth as succinctly as possible the tasks prescribed for Mr. Whale's new locomotives—see the issue of November 4th—I have next to show how these requirements are fulfilled in actual daily practice. I may mention that ten of the engines are now at work, viz., No. 2, Simoom; No. 7, Titan; No. 412, Alfred Paget; No. 510, Albatross; No. 513, Precursor; No. 659, Dreadnought; No. 1395, Harbinger; No. 1419, Tamerlane; No. 2023, Helvellyn; No. 2164, Oberon. All these names were borne until very lately by older locomotives which have been condemned. Thus the names Simoom, Albatross, Precursor, Harbinger, Helvellyn, and Oberon belonged to the old "Precursor" class, which had 5ft. 6in. wheels four-coupled and cylinders 17 by 24, and which were converted in the nineties into suburban tank engines. Titan, Dreadnought, and Tamerlane were 6ft. wheeled Webb compounds, and Alfred Paget was a 7ft. 6in. single wheeler.

As the coupled wheels of the new Precursor engines are described as 6ft. 9in. in diameter with new 8in. tyres, while those of the "Precedent" class are commonly known as 6ft. 6in., it might appear as if Mr. Whale had adopted a larger driving wheel than that of the previous non-compound coupled class, but as a matter of fact the wheels of the latter set, although still nominally 6ft. 6in., have long been 6ft. 9in. with new tyres, and so the "Precedents" and (new) "Precursors" have wheels of identical dimensions. But the newer locomotives have 2in. additional cylinder diameter and 2in. increased length of piston stroke, also virtually double the area of heating surface and 10 per cent. extra steam pressure. It will at once be seen at a glance at these figures how large an increment of power has been secured. The "Precursors'" work, at present, exclusively between Crewe and Euston, the section of the line on which the heaviest loads are habitually met with. Their duties may be conveniently classified in three divisions: (1) To haul trains of 18 to 25 "coaches," *i.e.*, 350 to 500 tons—including passengers, luggage, staff and stores—behind the tender, at average start to stop speeds of 50 to 53 miles an hour; (2) to haul moderate loads of 200 to 300 tons at average start to stop speeds of 54 to 58 miles an hour; (3) to haul trains of 300 to 425 tons at the high-booked speeds just mentioned. All of these weights are, of course, exclusive of the weight of engine and tender. The last duty is manifestly the culminating requirement, and I will therefore take it first in the order of actual results.

No. 1395, Harbinger, Edward Austin driver, was set to take a train reckoned as twenty-two coaches weighing 492 tons empty or 420 tons loaded behind the tender, from Euston to Crewe, 158 miles 7 chains, in 2 h. 55 min., averaging 54·2 miles an hour from start to stop. This was a sufficiently formidable undertaking for an engine with a load of 420 tons, nevertheless it would have been accomplished, if not with ease, at least with certainty, but for two relaying slacks, one very long and bad, the two involving a delay of practically four minutes. A severe pull is encountered almost immediately after starting from Euston in the shape of the Camden bank which rises at the rate of 1 in 70 for just about half-a-mile. This steep pinch was attacked by the new engine with unfailing energy, and was surmounted without the slightest approach to any difficulty. Then came the long although not steep pull to Tring. This involves practically 25 miles of constant collar work, for although it is true there is a short length of level and slight downward grade between Bushey and Watford, the advantage of this is seriously discounted by the fact that water usually has to be picked up at speed from the track trough. The Tring ascent may perhaps be divided into two lengths: Willesden—Watford and Watford—Tring. Up the former distance of about 12 miles our speed kept steadily at the minimum rate of 50 miles an hour. After passing Watford at 60, the rate did not go below 55 past King's Langley and Boxmoor. At Berkhamsted it had dropped to 50, and then it went down to the minimum point of all, 47·8 miles an hour, which was maintained up the final length of 1 in 330 until the Tring summit was breasted, 31 min. 33 sec. from Willesden, distance 26¼ miles. In descending the subsequent slight down grade no specially high speed was attained, the absolute maximum being 67·2 miles an hour near Leighton. Bletchley was passed 46 min. 13 sec. after Willesden, distance 41¼ miles. Up the seven-mile bank at 1 in 350 to the Roade summit speed never dropped below 50 miles an hour. Rugby was passed at reduced speed in 95 min. 3 sec. from Willesden, and Stafford in 56 min. 18 sec., inclusive, from Rugby, notwithstanding the very long and bad slack already referred to, and the final stop at Crewe was made, as stated above, in 2 h. 55 min. net from the Euston start. I have mentioned the "net" time thus prominently because it represents more accurately the locomotive work actually performed; but I may observe that the inclusive time, 2 h. 58¾ min., is better by 2¼ min. than the best booked time for the West Coast Scotch express from London to Crewe, the 11.50 p.m. being allowed 3 h. 1 min. for this stage. It is evident, then, that the same engine, given a clear road, could have hauled a considerably heavier train in the best Scotch express timing, and I have been informed, on trustworthy authority, that with this train, time has been kept with a load computed as "23½ coaches."

On another occasion the train was the 10.45 a.m. Euston—Liverpool express, which is timed to do the first stage of 133½ miles, Euston—Stafford, in 142 min., averaging 56·4 miles an hour. The engine, of the "Precursor" type, was No. 1419, Tamerlane, driven by Hughes. The train was reckoned at "18½ coaches," weighing 360 tons loaded, behind the tender—equivalent to 35 South of England "coaches" as these are computed. Good work was done from the outset. After getting clear of Willesden we tackled the 26¼ miles of almost unbroken ascent, mostly steeper than 1 in 400, with such vigour that the first 12 miles, viz., to Watford, occupied only 13 min. 14 sec.; the final 14¼ miles thence to Tring summit, the great part of which is at 1 in 330, without any break whatever in the continuous collar work, nevertheless took only 15 min. 36 sec. to cover. The absolute minimum, 54·8 miles an hour, was reached at a point between Boxmoor and Berkhamsted before the final unbroken stretch of 1 in 330 was entered upon. Up that stretch the speed, instead of falling as usual, steadily increased until, during the final mile to the summit, it was as high as 56·9 miles an hour, while the slight rising tendency had not ceased when the summit was reached. Down the succeeding descent the rate was high but by no means exceptional, the 15 miles from Tring to Bletchley, passing in each case, occupying 13 min. 16 sec. The Roade bank, 7 miles at 1 in 335, presented the next test of Tamerlane's climbing powers, and this was ascended without the speed dropping lower than 55·5 miles an hour. The subsequent rise to the Kilsby tunnel, most of which is at 1 in 340 to 1 in 400, hardly appeared to affect the engine at all, and its rate had not fallen below 60 miles an hour when the tunnel was entered. Rugby—82¼ miles—was passed in 86 min. 20 sec. from the Euston platform; 76 min. 50 sec. from Willesden, 77 miles. No further gradient difficulties remained, and Tamerlane sped swiftly along the easy Trent Valley road until checked at the junction with the loop line *viâ* Birmingham. But the Stafford platform was, nevertheless, breasted in 51 min. 9 sec. from the Rugby pass, although 1½ min. had been lost by the check just mentioned. The complete inclusive times were as follow:—Euston to Stafford, 133½ miles, dead start to dead stop, 2 h. 18 min. 25 sec., or 3 min. 35 sec. under booked time; Euston—Stafford, platform to platform, 2 h. 17 min. 29 sec., or 2 h. 15 min. net, there having been, in addition to the check referred to, a slight hindrance immediately after the Euston start, owing to the line-widening operations in progress. The principal passing times reckoned from Euston platform were as follow:—Watford, 17¼ miles, 22 min. 44 sec.; Tring, 31¼ miles, 38 min. 20 sec.; Bletchley, 46¾ miles, 51 min. 36 sec.; Roade, 60 miles, 64 min. 13 sec.; Rugby, 82¼ miles, 86 min. 20 sec.; Nuneaton, 97 miles, 101 min. 48 sec.; Tamworth, 110 miles, 113 min. 26 sec.; Lichfield, 116½ miles, 119 min. 19 sec. I may also note that the distance of 131½ miles from mile-post 1 to mile-post 132½ occupied only 130½ min.; the slight delays above mentioned occurred before and after those respective posts, and but for them it is obvious that the complete run would have been easily accomplished in 2 h. 15 min., from start to stop. Even without importing so much of hypothesis, it will be self-evident to every competent judge that the performance of Tamerlane was an exceedingly fine one, nor must a full share of credit be withheld from the skilful driver, Hughes, for the very able way in which he managed his engine.

The same locomotive and driver were called upon to take the Manchester and Liverpool up evening dining-car express from Crewe to Euston, which is allowed 2 h. 55 min. for the 158 miles 7 chains, involving an average start to stop speed of 54·2 miles per hour. In this case the load fell a little short of that in the instance just dealt with. It was calculated as 18 coaches, weighing with passengers, luggage, &c., 350 tons behind the tender. The prescribed task was accomplished with remarkable facility. Although starting from Crewe 1 min. 12 sec. late, we stopped in Euston 3 min. 5 sec. early, having performed the journey in 2 h. 50 min. 43 sec. The Whitmore summit was reached in 16 min. 57 sec. from the start—10½ miles of constant ascent at 1 in 177, 1 in 250, and 1 in 330. The lowest speed up 1 in 177, near Madeley, was 40·9 miles an hour, which increased to 47·4 up the subsequent 1 in 250 to Whitmore. Up the seven miles of 1 in 330 to Nuneaton the lowest rate was 55·5, and up the final six miles ascending at the same rate to Tring, a minimum of 52·8 miles an hour was maintained, excepting the final quarter-mile, when it momentarily dropped to 47·4. On the level and down grade the speed usually ranged from 65 to 70 miles an hour. The time from Stafford (passing) to Euston (stop) was 2 h. 19 min. 29 sec.; Tamworth—Euston, 116 min. 7 sec.; Rugby—Euston, 85 min. 35 sec.; Bletchley—Euston, 48 min. 26 sec.; Tring—Euston, 31 min. 36 sec.; Bletchley—Tring, exactly 17 min.; Tring—Willesden, 24 min. 29 sec.

Several other performances by these engines may be mentioned in less detail. No. 7, Titan, hauling from Crewe to Euston the Liverpool mid-day up express, the load computed as "23½ coaches," or approximately 460 tons exclusive of engine and tender, ran from Crewe to Rugby, 75½ miles, in 89 min., Rugby to Willesden in 86 min., thus gaining 5 min. in all upon booked time. No. 412, Paget on the same train, with "22½ coaches," or 430 tons, ran from Crewe to Rugby in 88 min., gaining 2 min. I am informed that engines of this type have kept time on the same train, whose two stages, Crewe—Rugby and Rugby—Willesden, are booked respectively at 50 and 51½ miles an hour, with trains of "25 coaches," or 500 tons loaded; but as I have not personally observed such a performance, I merely mention it "under all reserve." In one instance the same train, had it been run in its entirety, would have amounted to a load of 30 coaches. As, however, the rule prohibits anything in excess of 25, it was run in two parts. The first computed as 17 coaches, was taken from Crewe to Rugby by No. 2 Simoom of the "Precursor" type, which found a load of only some 320 tons, booked at 50 miles an hour start to stop, a quite insignificant drag. Merely playing with this load, booked at relatively low speed, the run was easily made in 5 min. less than the booked time. Two eight-wheelers from Birmingham and Leamington being added at Rugby, Simoom started thence with a load reckoned as 20 coaches, booked to run the 77 miles to Willesden at an average of 51½ miles an hour. This was more than accomplished, without effort. A rate of 53 miles an hour was attained before the first summit at Kilsby tunnel was reached. Thenceforward the run was made under easy steam to the stop at Willesden, again 5 min. under booked time.

Although the third phase of duty—second in order of sequence—which I mentioned at the outset as prescribed for the new engines, is, perhaps, less spectacular than the others, it nevertheless possesses notable attractions of its own. I refer to the running of moderately-weighted trains at specially high speeds. Two instances of this kind that came under my personal notice struck me as particularly good. No. 1395, Harbinger, again driven by Austin, was put on the 10.40 a.m. express from Manchester, which is booked to stop at Stafford only, and to reach Euston in 3 h. 30 min. In this case the inclusive load behind the tender was almost exactly 200 tons. We were slowed for relaying between Manchester and Stockport, thus losing more than a minute. We were also slackened past Stockport, and we had the usual long service slow through Crewe station and yards. Nevertheless, we got to Stafford, 55¼ miles, in 60 min. 22 sec., or in 59 min. net, making no allowance for the two service slacks. From Stafford to Euston we ran in 138 min. 34 sec. inclusive, reaching Euston 3 min. 2 sec. before time. As a matter of fact the engine had a very easy task all the way with such a load, albeit it would have been reckoned as "20 coaches" in the South of England. The speed kept steadily up to 56 miles an hour ascending the bank at 1 in 330, and was maintained at a very moderate rate on the falling gradients. But the most brilliant achievement of all in this class was accomplished with the fastest-timed train on the London and North-Western system, the Birmingham morning express, which leaves Euston at 9.20 a.m., and is booked to do the 88¼ miles from Willesden to Coventry in 92 min. start to stop, averaging 57·7 miles an hour. I travelled experimentally with that train on the first day it ran, when it was taken by a "Jubilee" compound, which lost 8 min. in the running. After that experience it almost invariably had two engines, although the load was only eight or nine 8-wheeled vehicles, of which one was slipped at Blisworth. The assisting engine was taken admittedly to ensure time being kept, and with a load of only four or five 8-wheelers per engine this, it is needless to say, was feasible enough. Latterly the train has been run by one locomotive of the "Precursor" type, which keeps time with quite ridiculous ease. One day lately I travelled specially by the train to test the fact, and the run of 88¼ miles from Willesden to Coventry was done in 85 min. 5 sec. platform to platform. The time from the Willesden platform to the Tring summit was 27 min. 27 sec. for the 26¼ miles, and the last 14¼ miles of this distance, all being on a rising grade, mostly at 1 in 330, occupied only 13 min. 46 sec. The speed in no instance dropped to 60 miles an hour, after that rate had once been attained, either up the Tring or Roade or Kilsby bank. Our times from Willesden platform were as follow:—Tring, 27 min. 27 sec.; Bletchley (41¼ miles), 40 min. 3 sec.; Blisworth (57¼ miles), 55 min. 1 sec.; Rugby (77 miles), 73 min. 29 sec. The engine was No. 2 "Simoom," and the very efficient driver, George Ward; Inspector Davies being also in general charge.

Enough for the present has been said to show what excellent locomotive work is being done by Mr. Whale's new engines. I have yet to describe the results of his modifications in the details of some designed and built by his predecessor.

* No. I. appeared November 4th.

THE BRIDGE OVER THE RHINE AT THUSIS.

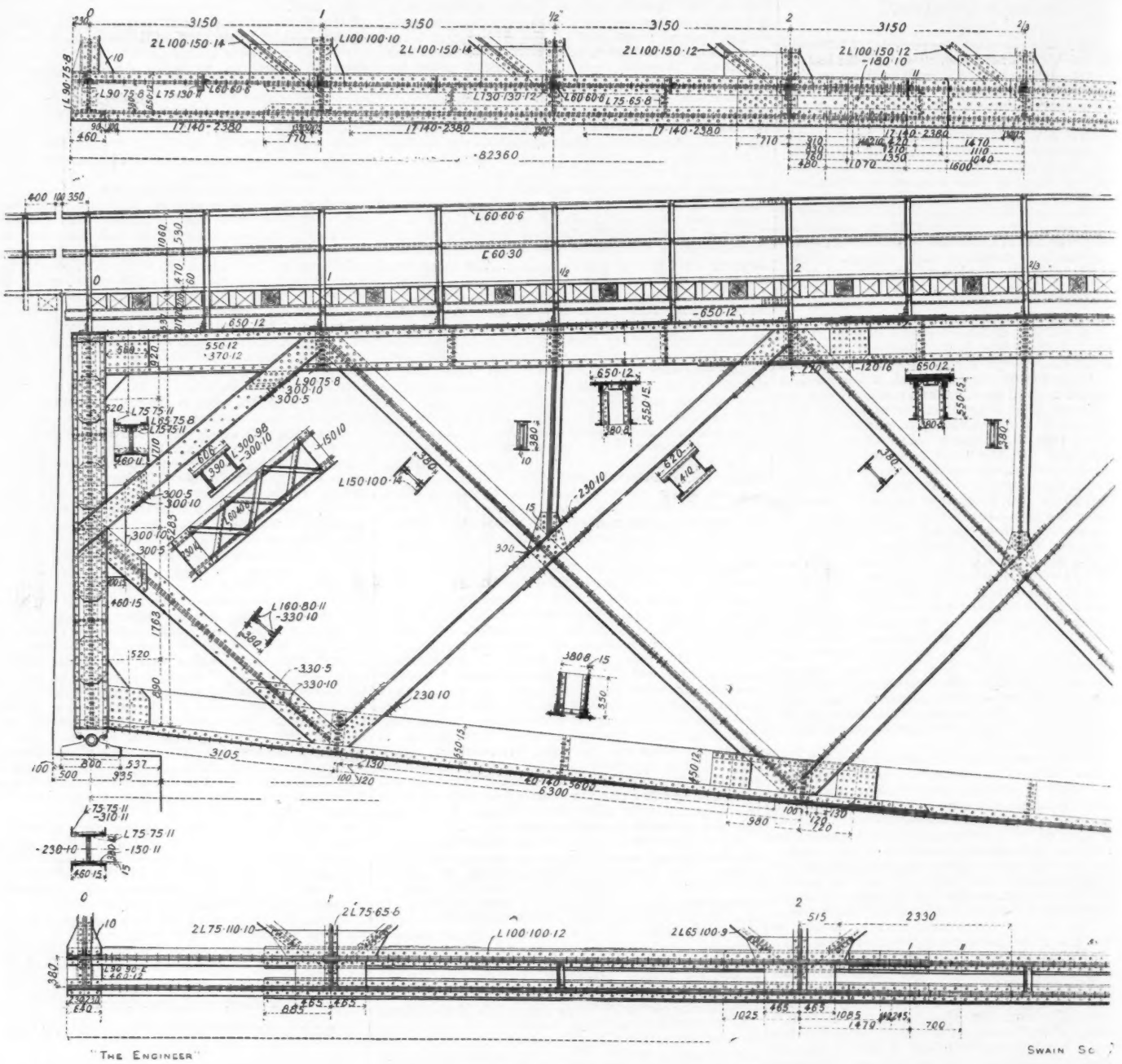
The steel bridge spanning the river at Thusis on the Albula Railway has an 80 m. clear span. On each side is an approach viaduct; that on the left bank of the river has three arches of 15 m. span each, and that on the right three arches of 15 m. and three of 11 m. span. The steel bridge was constructed by the bridge-building firm, Aktien Gesellschaft der Maschinenfabrik Theodor Bell and Co., of Kriens, Switzerland, from their own designs. Work on the staging was carried out during the winter 1900-1901. The erection of the bridge was commenced in May, 1901, and finished by the middle of August of that year, and the testing of the bridge took place on the following December 10th.

The bridge is on a 2½ per cent. gradient, has a distance between supporting points of 81·9 m. and a width between main girders of 5 m. The permanent way is on top of the girders and 23 m. above the river bed. A number of details are shown on the engravings given on page 513 and herewith. The main girders are of half parabolic shape, which not only involves a saving of material, but also lifts the underside of the bridge further above high-water line. This advantage is obtained by the curving of the lower instead of the upper chords. The upper chords being straight with the rails on the top also makes the whole arrangement simpler.

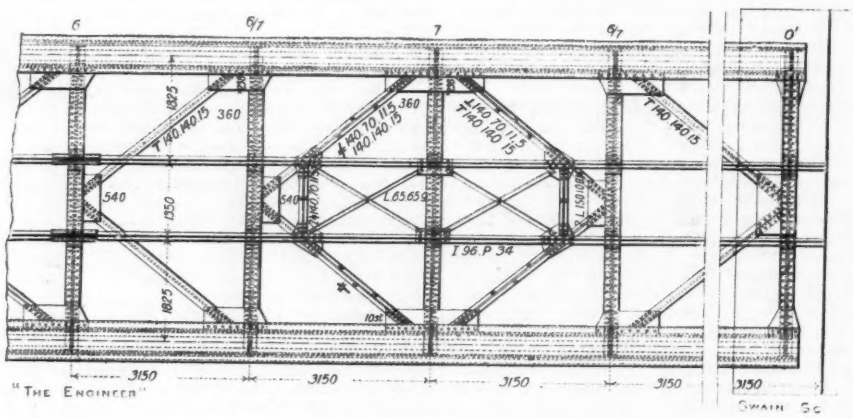
This bridge has three principal features, which are new at least in Switzerland:—(1) The leaving out of all vertical cross connections, although the rails are on the top. The cross stiffening is obtained by suitable strengthening of all horizontal connections. (2) The application to the main girders of the double triangular system of web members. (3) The arrangement of the stringers to run continuously over the cross girders, the former only being fixed to the cross girders at the middle of the bridge.

The main girders are 5·0 m. deep at the ends and 8·0 m. in the middle of the bridge. The cross girders are 3·15 m. apart, and at every second girder there is a vertical post connecting the corresponding panel point with the web members. The top and bottom chords of the main girders have got wind bracings, and these, in conjunction with the very strong cross bracing at both ends of the girders, and the very rigid panel points, give the structure great spaceal stiffness. The cross girders form the posts in the upper wind bracing. In the lower

RAILWAY BRIDGE AT THUSIS—SUSPENSION DETAILS



wind bracing the posts are so formed as to support a footway, which, for purposes of maintenance, runs along the lower chord of the girders. At each end of this footway there are ladders connecting it with the track-way. The stringers, to which the sleepers are fastened, run continuously on top of the cross girders, this arrangement possessing the following advantages:—(1) The secondary stresses caused by the alterations in length of the top chord of the main girders, when loaded, are diminished, these stresses affecting the cross girders as well as the top chord of the main girders and stringers. (2) The load on the cross girders only acts centrally and vertically as the forces acting in the direction of the track—effect of train including braking thrusts—are carried directly to the top chords of the main girders by means of a braking thrust bracing at the middle of the bridge. (3) The loosening of the rivets connecting stringers and cross girders, which frequently happens, is avoided. (4) The deflection of the continuous stringer is smaller, and smoother running is obtained than is the case with a series of short stringers riveted in between the cross girders.



FLOOR BRACING

The stringers have got a horizontal bracing, which also serves to carry the side stresses from the train on to the cross girders. The forces acting in the upper wind bracing are taken down to the bridge bearings through the strong vertical cross connections at both ends of the bridge. The cross girders connecting the lower chords at both ends of the main girders are made strong enough to permit of the lifting of the whole bridge by placing hydraulic jacks under them. At the trial loadings of the bridge the results were very favourable. The sideway vibrations amounted only to 3 mm.—1½ mm. to each side—at the middle of the top chords. On the bottom chords they were about 2 mm. No alteration of the rectangular shape of the cross section could be observed. At the same time strain measurements were carried out with the strain measuring apparatus on the Mantel system, according to the results of which it could be seen that the secondary stresses acting were but small, and considerably less than the amounts found by calculation. The lengthways movement of the stringers as the train passed over the bridge was clearly observable, and amounted to 3·5 mm. at the end of the bridge, which agrees with the corresponding calculation of the shortening of the top chords of the main girders. The maximum deflection of the main girders was 29 mm., compared with 34 mm. deflection as calculated. The permanent deflection of girders was only 1·9 mm.

All the girders were erected and bolted together in the bridgebuilders' shops at Kriens. All rivet holes were bored in position, and all the rivets put in hydraulically. The erection work was—as always is the case, so we understand, with the work of this firm—very much aided by reason of the excellence in design and accuracy in workmanship. The time occupied in erection, including the transport of the material from the station at Thusis to the site of bridge—a distance of 300 m.—was taken under separate heads:—

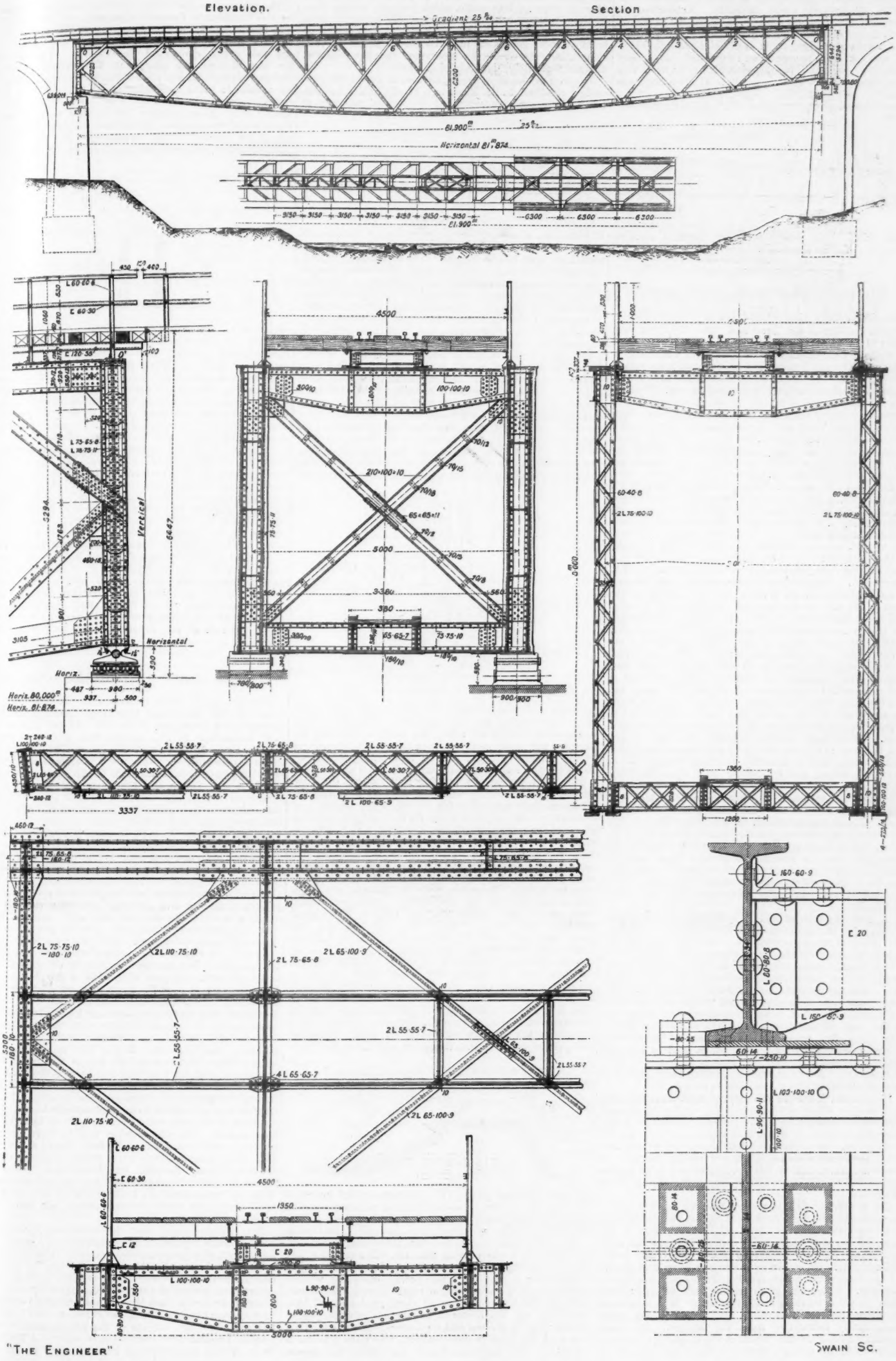
	Hours.
Chief erector	1020
Mechanics	2000
Riveters and labourers	22,000

The cost of erection amounted to 11,000f.—say £440, and the cost of the staging was 14,000f.—say £560.

The bridge was calculated for a uniform load of 3·8 tons per metre, and a rolling load of three locomotives of 48 tons each, and a train of ballast wagons each weighing 14·62 tons, the whole being arranged in accordance with

RAILWAY BRIDGE AT THUSIS—DETAILS OF STEELWORK

(*For description see page 511*

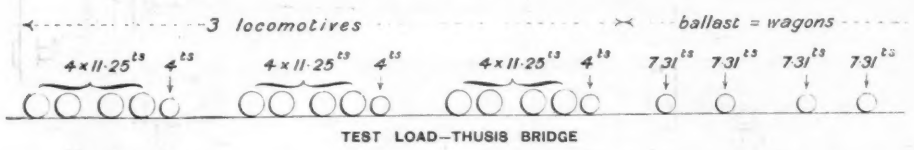


the accompanying diagram. The train used for the test loadings was made up in this manner.

The working out of stresses was very carefully and completely done in the offices of Messrs. Theodor Bell and Co., by graphic static methods. Authorities in Switzerland consider this bridge as a model, both as regards design and workmanship.

The weight of bridge, which is of mild steel, is 291·7 tons, and it cost, erected and finished, 460f.—say £18 8s. 9d.—per ton, this somewhat high price being due to the high prices of metal prevailing at the time it was erected.

Our illustrations on page 519 are reproduced from photo-



TEST LOAD—THUSIS BRIDGE

graphs taken of the bridge while in course of erection and while under its test loads.

THE IRON AND STEEL INSTITUTE.

AMERICAN STEEL AND WIRE COMPANY, CLEVELAND.

The members of the Iron and Steel Institute who visited Cleveland spent a whole day in the inspection of the works of the American Steel and Wire Company—a works which conduct operations on the grand scale, and in which a number of exceptionally interesting mechanical plants for handling material were seen in use. From a little brochure provided by the Cleveland reception committee, we learn that the American Steel and Wire Company owns three sets of furnaces and four works. The furnaces are the Central, the Emma, and the Newburgh. The first has three blast furnaces, one 75ft. by 20ft., built in 1881; one 80ft. by 20ft., built six years later; and one 100ft. by 22ft., first blown in in January, 1901. Two of these furnaces have been pulled down and others to replace them are in course of erection. The Emma furnace is 73ft. by 17ft., and dates back to 1872, but has been remodelled at various times. The Newburgh furnace is also a solitary stack, built in the same year; it is only 62ft. by 16ft., and was rebuilt some seven to eight years ago. All the furnaces use Lake Superior ore, which arrives in a finely divided state; it renders between 50 and 60 per cent. of pure iron. The product is Bessemer pig, which is converted in the Newburgh Works. The ore arrives at the docks or the river in ore-carrying steamers, and is raised in Hulett buckets straight from the hold by four Hoover and Mason machines, which, at the time of the visit, were building up huge stores of ore in preparation for the winter, when navigation is closed. The conveying machines employed are of great size, and consist of long steel gantries supported on trestles running on rails at each end parallel to the river. A hinged arm hangs out over the vessel to be discharged. A trolley driven along the gantry electrically carries the Hulett bucket out on to the arm, and lowers it rapidly into the hold of the ship, from which at each mouthful it picks out 5 tons of ore. It is then raised with its charge by wire ropes on to a hook on the trolley, and is instantly run backwards as far as may be required, and dumps its load upon the heap. In this way about 3000 tons can be handled in 12½ hours by each machine, the total number of men employed being only six, one manipulating each of the four machines, and two attending to the oiling, &c. In the early stages of unloading, whilst there is plenty of ore for the bucket to grasp, no men are engaged in the hold, but when the vessel is reaching emptiness large scrapers, directed by men but actuated by power, have to be brought into use to collect the ore in the centre of the floor, where the buckets may reach it. The whole plant is worked electrically.

Another very interesting conveying plant was also seen in operation, taking ore dumped from wagons in a siding, and piling it up for winter use. It was made by the Brown Hoisting Machinery Company, and consists of a gantry, 440ft. long, supported on three lofty trestles which run on three lines of railway over the ore field. The whole gantry can be swung horizontally about the centre trestle, it remaining at rest whilst the other two are caused to travel in opposite directions, the movement of the ends of the gantry being 90ft. in either direction from the central position. This ore handler has a 5-ton bucket operated by four wire ropes, and is directed entirely by one man, who can handle as much as 3000 tons per day. As the method of opening the bucket is a little peculiar, we give a hand sketch of it in Fig. 1.

Here A and A are the two parts of the bucket provided with arms to which are attached the closing ropes, and with rollers which slide on the guides B B, against which they are held in a suitable manner. As soon as the closing ropes are loosened the halves of the bucket run down the inclined slides, tilting and moving outwards at the same time, so that the opening is very large as the bucket enters the ore, which is drawn well into it as it closes.

The ore on this field is charged into the blast furnaces by an electric machine made also by the Brown Hoisting Machinery Company, of Cleveland. At the foot of the furnaces is a row of bins which contain the materials used in a charge, limestone, different grades of ore, and so on, but not coke. On a platform beneath these bins travels a bogie having two hoppers, each provided with a weighing machine. Below the platform the ends of an inclined railway, which leads up to the furnace summit, extend, so that the skip for conveying the material may come immediately below the travelling hopper. One man standing on the traveller operates the machine, running it about under the bins, the doors of which are opened by electric power, and allowed to discharge the required amount, a scale in front of the operator showing when the correct weight is reached. The hopper, thus filled with the proper mixtures, is brought to position, opens, and drops its contents into a skip, which instantly carries it up to the charging bell. The manipulation appeared to be very easy, and that only one man should be required to handle and weigh out the material was regarded as very remarkable. It should be mentioned that the coke was charged separately, one skipful at a time.

The iron produced in these furnaces is conveyed in a molten condition to the Newburgh Works, which has two large Bessemer converters of an annual capacity of 525,000 tons of ingots, four Wellman-Seaver open-hearth rolling furnaces of 50 tons gross capacity, and one stationary open-hearth furnace. The appliances for handling material are here again excellent. The ladles, charged with steel from the converters, are handled by an hydraulic crane of special design constructed by the Alliance Manufacturing Company, of Ohio, and only recently erected. It consists of a heavy column built up of plates and angles, standing vertically between the two converters. It supports by powerful ties a horizontal arm which, whilst remaining horizontal, can be raised and lowered several feet. On this arm runs a little bogie controlled by a hydraulic cylinder. The centre column, with the arm, bogie, and ladle, can be readily rotated, so that the ladle may be placed under the converter for filling, or swung round through 90 deg., and raised till it is over the ingot moulds. It closely resembles the ladle crane used for very many years in this country with Bessemer converters. The soaking pits are in close proximity; they are served by three electric cranes, all provided with long vertical rams sliding through guides, and raised or lowered

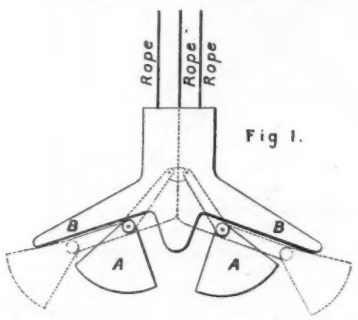


Fig 1.

by rack and pinion. Two of these are provided with claws for seizing the hot ingot and lowering it into or removing it from the pits; the third has means for grasping the moulds and stripping the ingots. The covers of the soaking pits are slid on and off hydraulically. From the pits the ingots are conveyed across the shop on a little conveyor to the cogging mills, where they are broken down to 7in. by 8in., and then to another mill, where they are reduced to 4in. by 4in. or 5in. by 5in., and sheared up into lengths suitable for the rod mills, to which they are carried on a suitable conveyor, which deposits them on the travelling belt of an Allen furnace. On this belt the billets, which weigh 158 lb., lie touching one another, and as they travel up the incline and slowly through the furnace they are brought up to the necessary heat for rolling. They drop from the furnace, one about every ten seconds, on to another conveyor, which takes them right up to the rod mills. When small sections are being rolled the end of the rod from the last rolls is led into a vertical column, which rotates rapidly, and which has a short arm inclined slightly downwards, through the centre of which the rod emerges, and is thrown out centrifugally beyond a number of steel pins or plungers projecting from an inclined plate and arranged in a circle, in a red hot condition, it is thrown round the pins, just as a rope might be thrown round them, and a coil is formed. As each coil is completed the operator pulls a lever, which withdraws the pins or plungers from its centre and allows it to slide

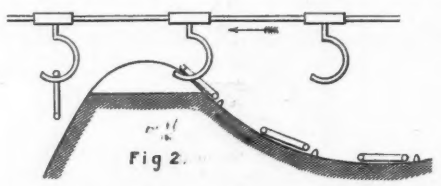


Fig 2.

down the inclined plate on to a conveyor, which pushes it up an incline, where a passing hook on a travelling rope catches it and bears it off to the pickling tanks. This arrangement is shown quite diagrammatically in the sketch.

The tanks are arranged in a row, three containing acid, one water, and one coating mixture. The coils as they come in are hung on rods, which are then rested on two crutches in a pair of large, slowly revolving wheels, which carry them up and deposit them in the liquid, through which they are moved slowly, rod and all, by a conveyor, till the crutches on another similar pair of wheels pick up the rod and its burden, raise it out of the one tank and drop it into the next, where the process is repeated. The diagram, Fig. 3, may make this clearer than words. A is the pair of revolving wheels, B is the coil of wire hanging from the rod C, on the point of being lifted out of one tank, and B^1 is the same coil in its second position.

The blowing engines used in these works were made by the Southwark Foundry Company, of Philadelphia, and by the Mesta Machine Company, of Pittsburg. The engines made by the former company for the converters are two cross compound horizontals. The valves for the blowers are placed in the cylinder covers, and the admission takes place through radial slots covered by a suitable valve oscillating about the centre of the cylinder cover and worked by an excentric on the crank shaft. The Mesta engines are vertical marine type. There are three separate engines, two working at high and one at low pressure. The blowing cylinders are driven from separate cranks and are on the same level as the

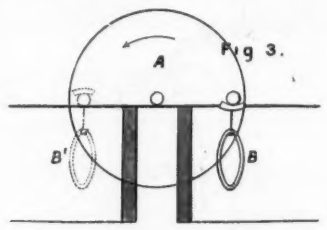


Fig 3.

steam cylinders. The air admission valves may be described as of the Corliss type. The delivery is through spring-loaded valves. The engines make forty-eight strokes per minute. They exhaust to a jet condenser with an independent air pump, made by the Conover Engineering Company, of Jersey City. The air pump is driven by a vertical engine, compounded in one cylinder by enlarging the piston-rod into a trunk and using the annulus for the high-pressure side. Corliss valves are used, the admission valve having a trip motion.

It may not be uninteresting to give the output of these steel works. At the Newburgh the open-hearth furnaces have an annual capacity of 143,000 tons of ingots; the large mill can turn out 440,000 tons of blooms, billets, and slabs per year; a new blooming mill has an annual output of 220,000 tons; and the rod mill 100,000 tons. The American Works, which has 2272 wire-drawing blocks, can turn out 125,000 tons of rods and 60,000 of wire; the Consolidated Works can produce 95,000 tons of rods, 80,000 of wire, and 1,100,000 kegs of nails every twelve months; and finally, the H.P. Works, where wire nails are made, can make 60,000 tons of rod, 90,000 tons of finished products, and 1,100,000 kegs of nails in the same time. These figures may give some idea of the great size of the works which are now associated under the title of the American Steel and Wire Company.

THE PORT OF LONDON BILL.

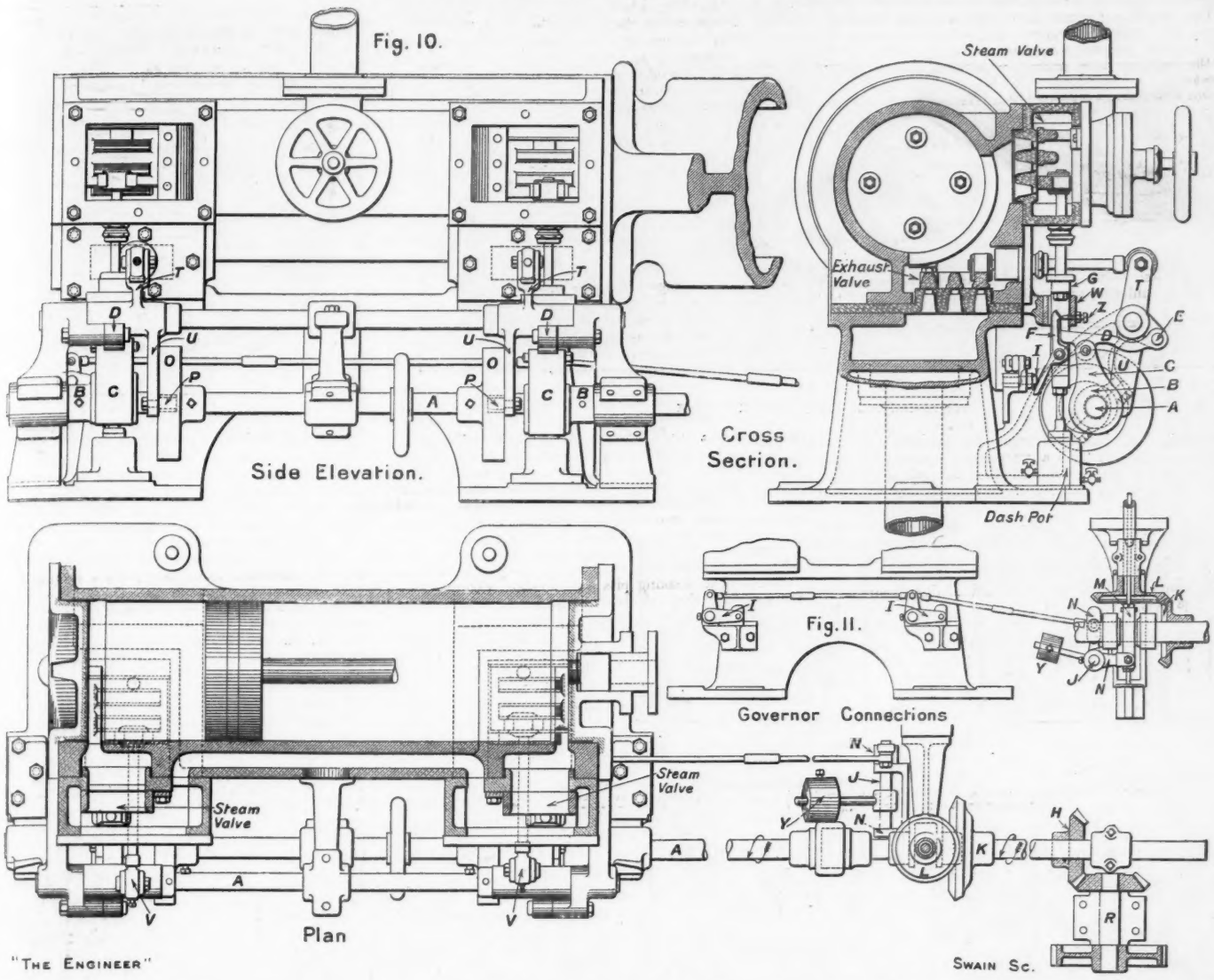
It is not our intention to enter into the details of the career of this abandoned legislative measure. A brief chronological retrospect of its rise and fall will be not only interesting to our readers, who are, to a certain extent, fairly familiar with its general provisions, but necessary, in order that they may understand the reason why its powerful influence still exists. The lines upon which it was drawn and the tenor and purport of its numerous clauses will no doubt serve as a very substantial and satisfactory reason for preventing more than one Bill being successful in next year's session. It was in last year that the Port of London Bill was introduced into the House of Commons by the President of the Board of Trade, and was read a first time. There were some seventy petitions against it, and in the following August it was agreed by the House, without a division, that further proceedings with respect to it should be suspended until the next meeting of Parliament in the ensuing year. The original Bill was amended by a Joint Committee in 1903, ordered to be printed in last May, and finally withdrawn during the past session.

Pending its withdrawal, a petition was presented against the amended measure by the Sheriffs of London, who attended for that purpose at the Bar of the House. The allegations against the Bill were of a somewhat general character. It was contended that the Joint Committee's inquiry of 1903 was inadequate and incomplete, that the scheme was of too exclusive a nature, and that the financial arrangements were unsatisfactory and required complete readjustment. It was also represented—and here, perhaps, may be found the gist of the objections—that the case of the City had not been sufficiently considered, and that the Corporation was entitled to have more than one member upon the Commission. This contention does not appear to be unreasonable until the constitution of the proposed corporate body is brought into the question. The Commission was to have consisted of six appointed members and others elected as provided. The appointed members were representatives of the London County Council, the Corporation, Admiralty, Board of Trade, Trinity House, and railway companies. With the exception of the London County Council, which was first with nine commissioners, all the others numbered but one apiece.

It is unquestionable that the withdrawn Government Bill embodied clauses of a far-reaching scope, and sought for powers of a very extensive nature. The cost of the interests and property it proposed to acquire has been estimated at £35,000,000. The creative, as well as the destructive, powers of the Bill were based upon the conclusions arrived at, and the recommendations contained in the report of his Majesty's Commissioners appointed to inquire into the subject of the administration of the Port of London, and other matters connected therewith. It is obvious that any new Bill dealing with the same

VALVES AND VALVE GEAR, 600-H.P. CROSS COMPOUND ENGINE

THE I. AND E. GREENWALD COMPANY, CINCINNATI, ENGINEERS



large question must necessarily be framed upon the same lines as those upon which its predecessor was drafted. It will be well, therefore, to take a brief review, without any useless recapitulation, of the principal features of the latter. In the first place, it proposed to establish a single public authority for the control, improvement, and management of the Port of London. This result cannot be effected in its integrity by any Bill, Act, or Ordinance, without abolishing the existing authorities who have hitherto been charged with the execution of those duties. Whether they have discharged them adequately or inadequately is for the present beside the point. Without in any way judging the matter, it may, we think, be fairly assumed that there are fair and reasonable grounds for the imputation that the duties were not performed in a thoroughly satisfactory manner. Otherwise, the promoters of the scheme might have had some difficulty in establishing a *locus standi*.

Another provision was that all the powers and property of the Thames Conservancy in connection with the river below Teddington should be vested in the aforesaid public authority. But the Thames Conservators objected to their own extinction, and their protest assumed the form of an opposing Bill applying for powers to constitute themselves the public authority. Owing to the considerable amount of opposition met with, this Bill fell through and was withdrawn after the first reading. It may be here mentioned that a deputation from the City, presided over by the Lord Mayor, waited last year upon the President of the Board of Trade, in the hope of inducing him to withdraw the Bill. The dock companies, also, took in their own defence similar retaliatory measures to those adopted by the Conservancy. They were threatened with the proposed transfer of all their powers and properties to the same public authority, and the menace constituted financially the heaviest provision in the whole Bill. These companies have always asserted that any apparent remissness on their part is owing to the fact that they lacked the necessary funds to perform their work properly and efficiently. Furthermore, they allege that they have never been permitted to utilise their property to full advantage, and that they have been debarred from earning an adequate revenue, because certain dues were denied to them, which are paid to dock companies everywhere else in similar circumstances. In the Government Bill there were also clauses introduced, obnoxious to the interests of the Watermen's Company, which were tantamount to repealing virtually its existing Acts.

There are at present in preparation a couple of Bills, which the promoters intend to introduce in the next session, which have for their object the solution of the problem of the future of the Port of London. One of these will enter Parliament under the auspices of the Thames Conservancy Board, and the other under those of the London County Council. The draft notice of the former of these was discussed, with closed doors, on the 7th instant, approved by the Board, and the promotion of the Bill determined upon. A resolution was proposed that the Bill should not be deposited unless and until the general agreement of the Board of Trade was obtained to its provisions. It was sagaciously observed by the opponents of the motion that the Board of Trade would refuse to give its views upon a Bill until the whole of it was before that department. We fully endorse the very probable accuracy of this statement, for two reasons. First, it would be premature, and also not in accordance with the usual custom of parliamentary procedure, for so prominent a public authority to support, and to a certain extent prejudge, previously to legislative examination and discussion, a measure fraught with such drastic consequences.

The second reason will be found in the attitude adopted by the Board of Trade, on a previously similar occasion already alluded to. The grounds upon which the proposed application was founded appear inept and insufficient, in relation to the magnitude and importance of the Bill. It should be, and was, regarded from a different standpoint than that of the mere expense involved in the promotion of Bills in Parliament. The motion was lost on a show of hands by twelve to six votes.

The adjourned report of the Rivers Committee was presented on the 8th instant to the London County Council. In a series of recommendations, which have already appeared in our columns, with respect to the administration of the Port of London, it was proposed that a Bill be promoted in the next session of Parliament for the establishment of a Port of London Commission, consisting of forty members.* The general tenor of the Bill is, *mutatis mutandis*, similar to that of the Government measure not proceeded with, so that it is unnecessary to refer again to the provisions and clauses. It should be stated that an amendment was moved to the effect that the report be recommitted, with instructions to the Committee to take expert opinion on the practicability of deepening the river by means of dredging. Notwithstanding the evidence given before the Royal Commission, we are disinclined to regard the difficulties connected with the dredging of the Thames as absolutely "insurmountable." That the cost would be very great is beyond question. Dredging operations always are exceedingly costly, but the Clyde would never have been the fine waterway it is if the millions spent upon deepening its channel during the last thirty or forty years had not been forthcoming. Other amendments were proposed, but they were all rejected, and the recommendations of the Committee confirmed. The Council is willing to contribute two and a-half millions towards the dredging of the river, the amount being spread over a period of ten years, to improve the port and docks, and to guarantee the money to purchase them. It is on the strength of these contributions that the Council considers it is entitled to monopolise twenty-four representatives out of the whole forty members composing the Commission. In any case, the exact constitution of it is not a detail of paramount importance. Exception is sure to be taken to it, and if met in a conciliatory spirit, the matter admits of ready adjustment. It may be here remarked that when the Government Bill was before the Rivers Committee last year, the Council, in order to avoid being subordinated to sectional interests, was content to be represented by fifteen members out of the total forty, instead of the original nine prescribed in the document. The London and India Joint Docks Committee is in the same position as the Conservancy, and naturally objects to the dismemberment of its several charges. It contends, in self-defence, that the municipalisation of the docks is unnecessary, uncalled for, and certain to produce far-reaching effects never contemplated by its promoters.

* "The Port of London." THE ENGINEER, 28th October, 1904.

THE INTERNATIONAL EXHIBITION AT ST. LOUIS.

(*By our Special Commissioner.*)

XXIII.*—STEAM ENGINES.

THE I. and E. Greenwald Company, of Cincinnati has a cross-compound engine of 600 horse-power, in which each cylinder has four gridiron slide valves. The cylinders are 18in. and 36in. diameter, and 42in. stroke. The engine runs at a speed of 100 revolutions per minute, and is directly connected to a 400-kilowatt 250-volt generator. The valves and valve gear are the special feature of the engine, and are illustrated by the sectional views in Figs. 10 and 11.

The steam valves are at the side of the cylinder, and have a vertical travel. The exhaust valves are under the cylinder barrel, and have a horizontal travel at right angles to the travel of the piston. Each valve has several ports or openings, the number varying with the size of the engine, but being sufficient to promptly ensure an ample area to maintain the closest approxima-

* No. XXII. appeared November 11th.

tion to the boiler pressure within the cylinder up to the point of cut-off in the steam valves, and to afford freedom from back pressure on the exhaust side of the piston in the case of the exhaust valves. All the valves are driven from a lay shaft parallel with the cylinder. The steam valves are operated by separate excentrics having sufficient angular advance to ensure a quick opening

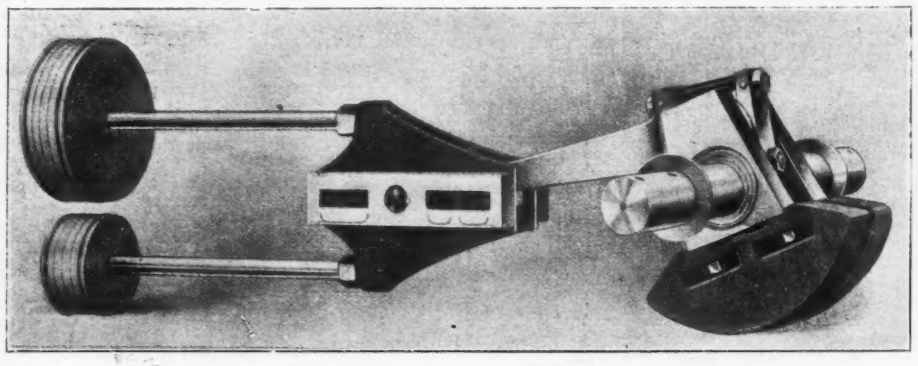


Fig 12—DRIVING GEAR, DUPLEX ENGINE

movement. The exhaust valves are operated from separate "wall cams," which give a very quick opening on the exhaust side of the piston, and close the valves quickly just as the stroke is completed.

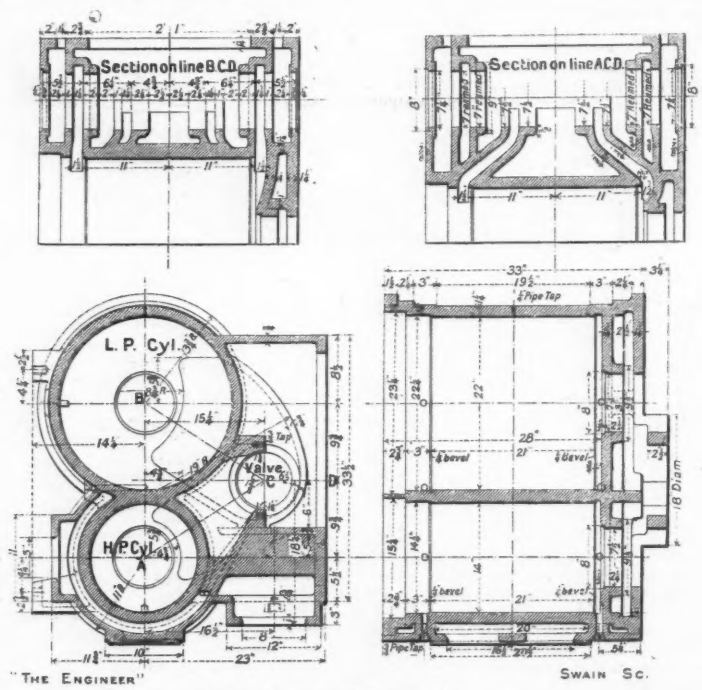


Fig. 13—SECTION OF CYLINDERS AND PORTS

The lay shaft is driven from the main shaft by a train of three spur gears, the first of which is on the main shaft, and the third on the short shaft R, which carries the bevel wheel gearing, with wheel H on the lay shaft. To reverse the direction of running, the wheel H is shifted to the other side of the bevel wheel on R. In the illustrations A is the lay shaft, B the steam excentric, and C a yoke secured to the lifting arm D, which oscillates on the bearing E. As the shaft revolves, the yoke lifts the arm D, the end of which engages with the hook F, which is pivoted to the vertical bridle rod G, sliding in the guides W. The arm will raise the hook and bridle rod until the tail of the hook strikes the tripper I, and is disconnected, when the dashpot will promptly pull down the rod and valve. The exhaust valves are operated by the cams O on the lay shaft A. These are wall cams, with grooves, in which travel pins P, attached to the lower end of the rocking arm U, whose upper end T is pivoted to the valve stem. As the head of arm T describes an arc, the end of the valve stem is fitted with a sliding box V, so that the motion is corrected to a straight movement for the valve. The steam valve seats form a part of the steam chest, and the exhaust chambers have false seats for the valves.

The centrifugal governor is driven from the shaft A by the bevel gear K L. The governor spindle is hollow, and within it is the rod which is attached to the arms of the fly-balls, and carries at its lower end the bridle M. This is secured to the lever N, keyed upon the shaft J, which also carries a second arm N. As the governor moves the rods up and down it causes the bell-crank lever to oscillate, and thus operate the trippers I—already mentioned—by means of the connecting-rods. These rods are provided with turnbuckles for adjusting and equalising the cut-off. In the guide W for the steam valve rod is a screw Z, which is a positive cut-off, by coming in contact with a steel plate on the hook F, and so pushing the hook back to release the valve rod at the extreme travel of the

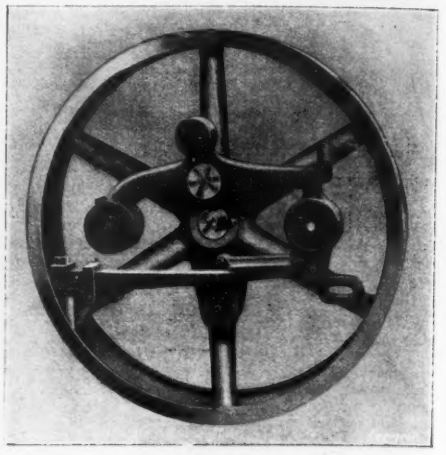


Fig. 15 GOVERNOR, SKINNER ENGINE CO

excentric on the full port opening of the valve. The speed of the engine can be varied by means of the adjustable weight Y on an arm attached to the bell crank N; the weight is moved inwards to decrease the speed, or outward to increase the speed. When the governor speed increases the tripping cranks or trippers I are moved down so as to release the steam valve and cut-off steam earlier. If the governors tend to lag, the trippers are moved up, and give a larger admission. A very large number of these engines are in service.

The A. L. Ide Company, of Springfield, exhibits a tandem-compound horizontal engine of 900 horse-

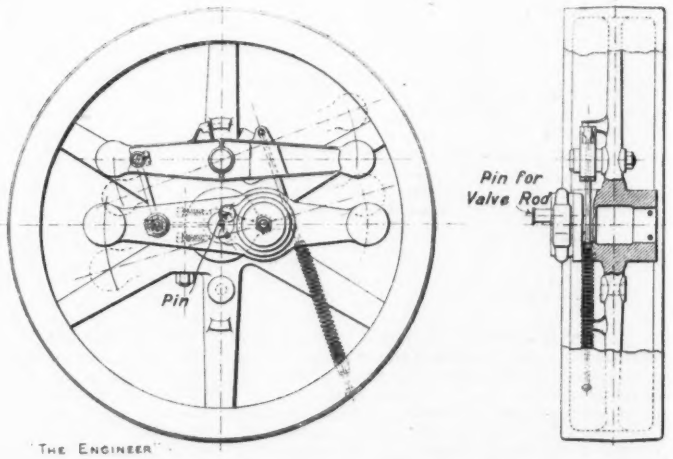


Fig. 14—INERTIA GOVERNOR AMERICAN ENGINE CO.

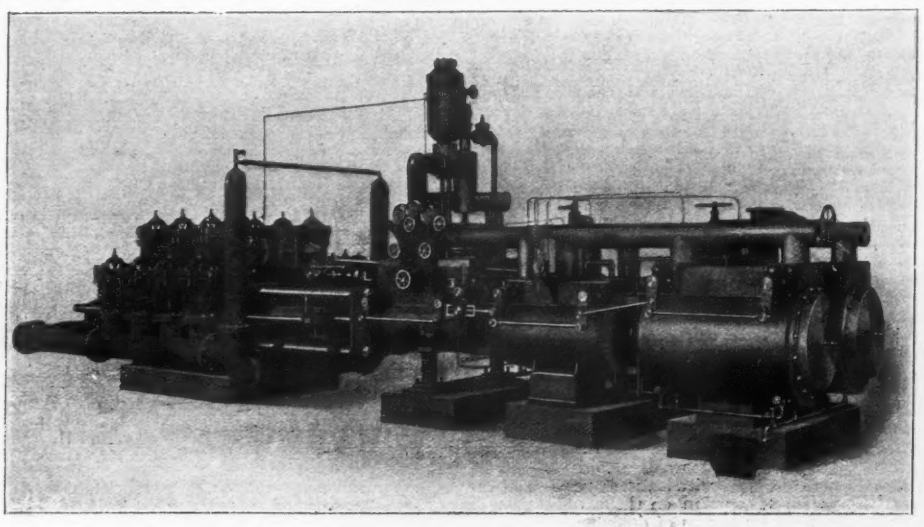


Fig 16—TRIPLE EXPANSION HORIZONTAL PUMPING ENGINE

power, which drives the 200-kilowatt 250-volt exciting unit of the 5000 horse-power engine and 3500-kilowatt alternator. The low-pressure cylinder is next to the crank, and the cylinders are coupled close together, with no stuffing boxes between them, the piston-rod sliding in a sleeve or bushing, the high-pressure exhaust discharging directly into the low-pressure steam chest. The high-pressure cylinder has a double-ported piston valve, while the low-pressure has a balanced slide valve. Both valves are attached to the same valve rod, which is driven directly from the excentric, although in most engines of this class there are rocker arm connections. The governor is of the inertia type, and shifts the position of the excentric upon the shaft. The working parts are enclosed, and the crank runs in an oil chamber, with splash lubrication for the slide bars. The engine has cylinders 13in. and 26in. diameter, 18in. stroke.

The remaining three engines are of the smaller class of horizontal "automatic" engines. The American Engine Company has a duplex compound engine of 200 horse-power, in which the cylinders are placed one above the other, and have both piston-rods attached to the same crosshead, as in Fig. 12. A solid piston valve is used, with the parts split horizontally, so that the parts can be separated by copper strips, as the chamber wears to an oval section. Between the steam chest and the fly-wheel is a short shaft with two upright rocker arms. Fig. 13 is a section of the cylinders and ports. To one of these is attached the valve rod; to the other is attached a rod whose further end is fitted to a pin attached to one of the two levers of the inertia governor—Fig. 14. The engine has cylinders 14in. and 22in. diameter, 16in. stroke, and is run at a speed of 230 revolutions. The fly-wheel is 6ft. 6in. diameter, and weighs 1½ tons. The engine is directly connected to a direct-current generator of 125 kilowatts, 125 volts. The Skinner Engine Company has a simple engine of 200 horse power directly connected to a direct-current generator of 150 kilowatts, 2500 volts. The slide valve has its rod connected to a horizontal lever pivoted to a bracket on the frame. The outer end of this lever is connected by a rod to a pin on the governor. The governor—Fig. 15—consists of a

main arm turning on a steel pin in the fly-wheel, and connected by a weighted link to a leaf spring carried by lugs on the fly-wheel rim. The main arm has the spherical wrist-pin from which the valve-rod is operated. This engine has a cylinder 18in. by 18in.

The Buffalo Forge Company's engine is of 175 horse-power, and is a tandem compound, with the high-pressure cylinder at the crank end and the low-pressure cylinder at the rear, supported by a pedestal on an extension of the bed-plate; this pedestal also forms the exhaust pipe connection. The crank and reciprocating parts are enclosed, and run in oil. The cylinders are 18in. and 22in. diameter, 14in. stroke, and the engine was designed to carry the full capacity of an alternator of 132 kilowatts, the engine running at 225 revolutions, and having 125 lb. of steam at the regulator. The high-pressure cylinder has a packed piston valve, and the low-pressure has a double-ported balanced slide valve; the travel is 5in. for the high and 4¼in. for the low-pressure valve. The valves are on opposite sides of the engine, and each is driven from an excentric on the main shaft, the excentric-rod and valve being connected by a vertical rocker arm. The governor is of the inertia type, with a leaf spring and a counterweighted arm in gravity balance, so as to make the governor very sensitive, and to permit of easy adjustment. A regulation of within 1½ per cent. is guaranteed. The engine has a fly-wheel 5ft. 6in. diameter.

The remaining engine of the power plant is a triple-expansion horizontal pumping engine, which delivers 1200 gallons of water per minute at 300 lb. pressure to an impulse or jet water wheel of the Doble type. On the shaft of the wheel is a generator of 100 kilowatts, and the power of this unit is rated at 170 horse-power. The engine—Fig. 16—built by the Jeanesville Ironworks, at Jeanesville, is a direct-acting duplex engine, of the type built for continuous heavy lift mining service, where economy in steam consumption and reliability of operation are of the first importance. The cylinders are steam jacketed on the barrel and head. Steam entering the high-pressure cylinders on each side of the pump at 150 lb. pressure is exhausted directly into the intermediates and thence into the low-pressure cylinders through connecting pipes, as in the Woolf type of engine; thence it goes to the surface condenser, which is placed in the suction pipe, so that all the water passes through it. The cylinders are 11in., 17in., and 30in. diameter, with a stroke of 36in. Each cylinder is provided with two semi-rotating valves actuated by the plunger crossheads, forming the "duplex" valve movement, and each high-pressure cylinder is fitted with an adjustable cut-off, which may be set to cut off at any desired part of the stroke while the pump is in operation. The water cylinders are connected to the steam cylinders by eight heavy steel tie rods, and have double-acting outside end packed plungers 10in. diameter. There are sixteen pot or valve chambers, each provided with four bronze wing valves working on bronze seats. Provision is made for regulating the lift of these valves by an adjustable guard, whose stem is brought out through the chamber cover, and may be set to any desired position by means of lock nuts. The engine has a Wyoming eliminator on the steam pipe, and is fitted with the Fisher governor, which has been described in an earlier paper. The water wheel driven by this engine is 31in. pitch diameter, with ellipsoidal buckets, and runs at 700 revolutions per minute. The water jet is 1¼in. diameter, controlled by a needle nozzle operated by a Lombard hydraulic governor. In case of a light load, the surplus water from the pump is taken care of by a by-pass terminating in a 9in. balanced relief valve. A 10in. Venturi meter with register indicates the quantity of water delivered to the wheel, and a recording pressure gauge shows the pressure, including the losses in the nozzle and its connections to the meter. The speed is shown by a shaft tachometer, driven without a belt.

With this paper the description of the engines at the Exhibition is concluded, and it may be said that these various engines, of 50 horse-power to 5000 horse-power, with their several auxiliaries, form one of the most complete and comprehensive sections of the entire range of exhibits. The only omission made is the steam turbine, but this will form the subject of a separate paper.

THE INSTITUTION OF MECHANICAL ENGINEERS.

The second meeting of the Institution of Mechanical Engineers was held last Friday evening in their buildings in Storey's-gate. The subject of the paper was "Impact Tests on the Wrought Steels of Commerce," by Mr. A. E. Seaton—member—and Mr. A. Jude. The minutes of the last meeting having been read and the transference of an associate member to member taken place, the President, Mr. Wicksteed, then asked Mr. Seaton if he had anything to add to the paper before it was read. Mr. Seaton, who was warmly received, remarked that the paper was the result of experiments made five years ago, after a serious accident had occurred. He does not consider that the tests which are applied to-day are sufficiently untrustworthy to be of great value to the engineer. He took this opportunity of thanking Mr. Jude for his assistance, and also for taking all the photographs, of the sections of the different specimens which are given in the paper. He hoped the discussion would lead engineers to consider the matter carefully, and to substitute a new method for those at present in existence. The machine devised by the authors he believed to be a good one, and quite sufficient to gauge the merits of all classes of steel. In conclusion, he regretted that his friend, Mr. John Spencer, was not there to take part in the debate, as it was he who commenced the heat treatment of steel, and also pointed out that a fine grain fracture was coincident with toughness, and that a coarse grain fracture was allied to brittleness. The paper was then read in abstract, and afterwards some excellent slides of microscopical photographs of steel were then shown on the screen, and an interesting explanation given by Mr. Jude. There is practically nothing to say about these photographs, except that they clearly showed that the fracture in nearly every case went through the ferrite and avoided the pearlite. After the photographs had been shown, the chairman said that he was sure the meeting would wish him to convey their thanks to the authors for their valuable and instructive paper. He did not think that anyone had seen such beautiful photographs of cracks before. He had much pleasure in passing a vote of thanks to the authors for their valuable and instructive paper.

Professor Arnold was then asked to open the discussion. Professor Arnold's was by far the most characteristic speech of the evening. He said he had read the paper with great interest, and on the whole was in agreement with what the authors had written, but there were one or two items with which he did not agree, and which were open to argument. He wished to endorse the statement made at the commencement of the paper in reference to carrying out the tests with thoroughly representative samples and not fancy steels. At Sheffield University he cast two tons of metal before taking a sample, and he considered the specimen must be taken from a 10in. square ingot before they are of any value to the engineer. But he admitted that a fancy steel was necessary for such purposes as armour plating and in other cases where the shock the steel was subjected to was considerable. Professor Arnold then referred to two tables given, one of an analysis of stresses in the steel parts of an up-to-date engine, and the other being curves showing failure under reversal of direct strain. These he considered extremely instructive. He also agreed with the author in relation to a fine grain steel being more trustworthy than a coarse grain; but this statement was not absolutely true, as he knows of cases where this theory has not been substantiated. In reference to the apparatus devised by the author, he considered it was a good machine, but thought it was inefficient in timing the blows. It is a most important point that they should be evenly applied, the slightest deviation from this causing considerable differences in the results obtained. The Professor drew a rough sketch of a machine he had designed, and which was illustrated in our impression for Sept. 2nd, in which the test piece was subjected to alternating shock, applied at the rate of 800 revolutions per minute, and with this he had obtained trustworthy results. If the authors got an appliance by which even intervals between the shocks could be obtained, then he thought their machine would become more of a standard character. Continuing, Professor Arnold then dealt with points in the paper that come more in his sphere than the author's. In the first case, Mr. Jude had given as his opinion the statement that the reason the fractures ran along the junction of the pearlite and ferrite was because of cleavage, and also because the orientation was similar, but if it had been there would have been no junction, and that being so, it follows the author's reason must be wrong. Professor Arnold thought that a more reasonable solution lay in the fact that there were two-thirds ferrite and only one-third pearlite.

At this point Sir William White asked Professor Arnold if he could explain the phenomena already referred to, but in answer to Sir William, Professor Arnold said he was unable to do so. He then went on to discuss the use of the word "eutectic," which enters into one of the sentences in the paper. The sentence referred to runs as follows:—"This pearlite, which is the eutectic or mother liquor, solidifies last, and may be considered to partake of a crystalline nature, when, as is generally the case, the alternate layers of ferrite and composite carbide lie parallel to one another in definite patches."

Professor Arnold pointed out that pearlite is never fluid. When steel had ·9 per cent. of carbon in it, the Professor had called this steel "saturated"; if it contained more than this quantity it was called "super-saturated," and if containing less, the term unsaturated was given to it. Much amusement was then caused by quoting the names given to this condition of steel by other scientists. Another school had substituted the word "eutectic," but this, he said, was obviously wrong; and various metallurgists knowing this, suggested the terms in the order given:—(1) Eutectic, hypoeutectic, hypereutectic. (2) Eumetallactic, hypoeumetallactic, hypereumetallactic. (3) Eumetamorphic, hypoeumetamorphic, hypereumetamorphic. (4) Benmutic, hypobenmutic, hyperbenmutic. (5) Aeolic, hypoaeolic, hyperaeolic. (6) Eutectoid, hypoeutectoid, hypereutectoid.

But, added Professor Arnold, amidst much laughter, "my own terms will suit me to the end of the chapter." In conclusion, he wished to thank the authors for their most valuable paper. Mr. Stromeyer was then asked by the President if he would say a few words on the paper. In replying, Mr. Stromeyer said the paper was one of extreme interest and usefulness, but he objected to the title. He considered that the authors had not dealt with the question of impact tests as much as they ought to have done, as in its present state it left many points of great importance in a doubtful state. By looking at the diagram of the curve of maximum shock strength of commercial "pearlitic" steels, it will be seen that the spots indicating experiments show blows ranging from practically 0 to 6½, and that the number of blows are not at all definite; and a reference to Table I., which gives a tabulated form of the experiments, shows that in the first specimen the samples have broken with a vastly different number of blows. The speaker added that the Admiralty and Lloyd's went into the matter thoroughly when mild steel was introduced, and came to the conclusion that the tests at present used were the most suitable for general practice. In the paper the authors refer to the fracture of steel through fatigue, and state that this rarely happens; but Mr. Stromeyer does not agree with them, and quoted the instance of the breaking of the tail shaft in the steamship City of Paris; he believed that Professor Unwin had stated that the breakage was due to fatigue.

Mr. Milton was the next speaker. He appreciated fully what the authors had said in their paper of substituting new tests, but does not consider that the reversal of strain, given in either the author's machine or Professor Arnold's, entirely meets the necessary requirements, as he thinks that the tests are too severe. With regard to the fracture of the steel specimens already referred to, Mr. Milton thought that the fact that the fracture followed the junction of the pearlite and ferrite was due to cleavage. He explained that in one plane the faces of the crystals are parallel and in the other they are not. He had examined many broken mild steel shafts and cranks, and invariably the fracture had avoided the pearlite.

Sir William White, who nevt addressed the meeting, said he had read the paper with care and interest, and he noticed that the discussion had been confined to be of value from the point of view of users only. Drawing attention to a paragraph in the paper which runs, "The majority of steel users require that they shall be able to use an ordinary steel as supplied to them, and without annealing, tempering, or other heat treatment. The authors therefore urge that the engineer should demand of the steel maker a greater attention on his part to produce and supply the ordinary grades of steel with a more uniform shock quality," Sir William White said that if this was so, then ordinary steel supplied must have different qualities for different purposes, and in that case no universal test could be of any use. Some years ago, when Mr. Yarrow went to the Admiralty with reference to quick-running engines, he tried to discover the best class of steels to overcome the shocks to which this class of engine is subjected to, and had designed a testing apparatus which he believed would be shown to the members later in the evening. Sir William White thinks that the tests at present in use meet all the conditions, but admits that there are some fittings on ships for which it would be advantageous to adopt nick tests. He also referred to the useful work done in the past few years by the Alloys Research Committee.

Mr. Harold Yarrow then showed the testing apparatus referred to, and demonstrated its action by breaking a test piece. The principle of the machine is simply allowing a weight of 10 lb., guided by a tube, to drop through a distance of 18in., on to the test bar, which is 4in. long, the distance between the supports being 3in. The section of the specimen is half a square inch.

Dr. Stanton was then asked by the President if he would make a few remarks on the paper, and in reply Dr. Stanton said he did not doubt the value of the paper nor what the authors had said about shock tests, but he had been making experiments at the National Physical Laboratory on what was called "proof resilience," which he considered was of great importance to steel users. Proof resilience defined, meant the maximum amount of work that can be put upon the steel without having any effect upon it. It can be obtained on an ordinary machine by the use of an extensometer, and is expressed by the formula: $\frac{1}{2} \cdot \frac{f^2}{E}$, which for mild steel Dr. Stanton gave the value 50. He greatly believes that the proof resilience in inch-pounds per cubic inch would be a most valuable quantity for engineers to obtain.

Mr. Turner, who made some interesting comments on the paper, had the disadvantage of speaking late on in the evening, and it was apparent that he was unable to deal with the points he raised as fully as he would have liked to have done. He said he owed a debt of gratitude to the authors for bringing forward the subject of shock tests, as he considered it a very important one, as to obtain an accurate knowledge of the physical properties of metals, impact tests are very valuable; but, at the same time, he considered that nicks in the test bars should be avoided or standardised. Mr. Turner also referred to the interesting diagram showing the linear expansion of pearlite and ferrite, and pointed out that if the authors had continued their experiments, they would have found that the difference of expansion of the two would have been considerably greater at the higher temperatures.

Mr. Turner having concluded, the President adjourned the meeting till Friday, December 16th, and announced that the discussion would be continued, and that there would also be a paper read on an allied subject, so that all interested in this subject would also be interested in the next paper. The meeting then adjourned.

THE INTERNATIONAL ENGINEERING CONGRESS AT ST. LOUIS.

No. III.*

RAILWAY TERMINALS.

The paper by Mr. Ernest Pontzen briefly described developments in France in the improvement of passenger termini, and the introduction of machinery for handling goods and cargo at the ports. Methods of handling luggage were also mentioned. A larger paper by Mr. Elmer Corthell, of New York, described the general features of several of the leading passenger termini of America and Europe, but there was no discussion of the several principles or conditions to be observed in the design of such stations. A paper by Mr. William T. Foxlee, M. Inst. C.E., gave particulars of a number of British passenger and goods stations, and also the terminal works at Southampton, Barry, and Heysham.

The discussion was opened by Mr. Greensfelder, assistant engineer of the St. Louis Terminal Association, which association operates all the terminal lines and the great union or joint station, and is composed of representatives of nearly twenty railways entering the city. He described particularly the extensive improvements made in the station itself, and the entire reconstruction of the railway approach lines to give greater traffic facility. This station has been described in The Engineer. A peculiar feature is the use of the double-

* No. II. appeared November 18th.

gate system to weed out loiterers from *bonâ fide* passengers. Mr. Corthell thought that 15ft. should be a minimum width for platforms. Mr. Tratman pointed out the importance of the track approaches, and the position of carriage cleaning and storage yards, engine sheds, coal and water supply, &c., in relation to the efficient and rapid handling of traffic at large termini. He also referred to the lack of general recognition of principles governing the arrangement of goods yards, and to the economy of space effected by the use of warehouses two or more storeys high, with lifts carrying the cars from floor to floor. The English practice of using flying junctions on busy lines, to avoid detentions and chances of accident, was endorsed. Mr. Moore spoke of the present tendency to use "umbrella" shelter roofs over station platforms, instead of great train-shed roofs covering the entire station. The new joint station at Washington will have this arrangement, with roofs wide enough to extend partly over the carriages, and sloping down to a middle gutter over the centre of the platform.

UNDERGROUND RAILWAYS.

Three interesting papers were presented, all dealing with lines for local city traffic. Mr. William Barclay Parsons, Chief Engineer of the New York Rapid Transit Commission, described the three American lines; New York, 15½ miles; Boston, 3·1 miles; and Philadelphia, 2 miles. The last is under construction, and the other two cities have 3¼ and 1¼ miles still under construction. The characteristic features of these railways, in which they differ from British practice in similar railways, are as follows:—(1) Closeness to street surface; (2) use of steel beams in walls as well as in roofs; (3) simplicity in design of steel structure; (4) the use of concrete instead of brick or stone; (5) the use of reinforced concrete; (6) the addition of extra lines of rails for express trains or special service; (7) freedom in design, whereby the general type of structure is changed to meet local requirements. In all these cases steel posts support steel roof beams, and both posts and beams are embedded in concrete. There are about 4000 tons of steel per mile of four-track structure. Electric power is used, generated at 11,000 volts, and transformed and reduced to 550-volt direct current at sub-stations. There are no classes, and a uniform fare of 2½d. is charged. The Boston line is used by trains and tramcars. The Metropolitan Railway system of Paris was described in a paper by M. Biette. The city undertakes all construction work for the line and stations; the Metropolitan Railway Company provides the permanent way, electric equipment, power stations, sites for stations, and all the rolling stock. The rates per trip are 0·25f. first class and 0·15f. second class. The total length of the eight lines will be about 52 miles. The construction consists of a double-line masonry tunnel, as near the surface as possible; the line under the Seine, however, will have two single-line iron tubes. Shunting is avoided by the use of loops. A short paper by Basil Mott and David Hay, Mems. Inst. C.E., renewed the old shallow steam lines and deep-level tube railways of London, and indicated that the expense of and restrictions imposed upon underground railways had become so great that "it is doubtful, when the lines at present under construction are completed, whether any further railways, either in the form of shallow subways or as tubes, will be constructed in London, at any rate, by private enterprise."

In the discussion, Mr. Moore spoke of the important matter of the relations between the municipal authorities and the railway companies. Mr. Tratman showed that in London there has been no attempt to form a comprehensive system adapted to the needs of the public—each company building its line for a certain route of traffic and opposing lines which might encroach upon what it considers its rightful territory. In Paris the municipality has decided upon the routes, and is building the lines; while in New York and Boston, special municipal commissions have laid down the routes, planned and supervised the construction and equipment, and will supervise the operation. Some speakers thought that lifts would not be adaptable to American conditions, where people hurry and rush more than in Europe. Deep-level lines would not be so satisfactory as shallow lines for short distance travel, and all American lines are kept as close to the surface as possible. Mr. Kamp spoke of the deep-level tunnels in Chicago, but these were built for telephone purposes, although it is now proposed to utilise them for a narrow gauge system of railways for goods, parcels, mails, coal, &c., connecting the various railway stations, post-offices, warehouses, goods stations, &c. Mr. Tratman remarked that the use of motor cars instead of electric locomotives is the general practice, and that locomotives had been abandoned in the Central London Railway as a result of investigations into the cause of severe vibrations in buildings near the line.

VENTILATION OF TUNNELS.

The paper by Mr. Francis Fox, M. Inst. C.E., stated that the use of a large ventilating fan in railway work was first applied in March, 1870, by Mr. Ramsbottom, at the Lime-street tunnel of the London and North-Western in Liverpool. Mr. Fox thought that if the Metropolitan and Metropolitan District railways, of London, were not about to be electrified, it would be absolutely necessary to apply mechanical power for putting the air of these tunnels into a satisfactory condition. "If railway engineers would adopt for tunnels the same rules as are applicable to mines, much of the difficulty would disappear." The paper discussed the degree of purity to be aimed at, and described the ventilating methods of the Severn, the Mersey, and other tunnels, including the plan devised by M. Saccardo—of the Italian railways—for utilising the fan on the injector principle.

A larger paper by Mr. C. S. Churchill, chief engineer of the Norfolk and Western Railway, U.S.A., partly covered the same ground and in more detail. It also entered into American as well as European practice. Fans are used in several cases for city, mountain, and submarine tunnels. In two cases on the Norfolk and Western Railway the Saccardo system has been adopted, the fans being placed at the larger end of the injector nozzle, which delivers air around the perimeter of the tunnel. This has effected great improvements, the blast clearing the tunnel very quickly, and eliminating the former discomforts and dangers to which the train crews were subjected.

Mr. Wm. B. Parsons, Chief Engineer of the New York Underground Railway, thought it would be impracticable properly to ventilate a steam line, subway, or tunnel with heavy traffic. Mr. Churchill said that the use of the Saccardo system for one of the tunnels on the Norfolk and Western Railway, U.S.A., had resulted in preventing the moisture which generally collects on rails in tunnels, so that with the better rail conditions the goods trains are now made 100 tons heavier, and the number of trains consequently reduced. The decrease in train expenses is £343 per month, and the operation of the ventilating plant costs £54 per month, leaving a net saving of £289 per month. The discharge from the locomotives comprises 45 per cent. of hot air and 55 per cent. of noxious gases. He did not agree with the remark made by Mr. Parsons as to the ventilation of tunnels operated by steam locomotives. A further advantage of efficient ventilation is that with the drier air the oxidation of the rails is reduced and there is little of the fungus growth on the walls which, in a damp tunnel, causes the decay or disintegration of the lining.

LOCOMOTIVES AND ROLLING STOCK.

The present practice and equipment of French railways was outlined in a short paper by M. Edouard Sauvage, in which it was stated that the interest of French locomotive practice is centred in the development of the four-cylinder compound, and in most cases the high and low-pressure cylinders drive separate axles, which are coupled. The advantages are economy in coal or greater power with the same coal consumption, good utilisation of steam at high pressure, good balancing, counterweights required only for the revolving parts, and ample bearing surfaces. The Serve ribbed tubes are now generally used, and piston valves and the Walschaert valve motion are in general use. The piston valves give larger ports, and so reduce wire-drawing and compression of steam, while in some cases they have effected an economy of coal as high as 10 per cent. Passenger carriages are now generally of the corridor type, with compartments. The wagons are usually of 10 tons capacity, sometimes 15 and even 20 tons. Steel bogie wagons of 40 to 50 tons capacity have been built, but their use is as yet limited.

The paper on "American Locomotives," by Mr. William Forsyth, reviewed the development since the Engineering Congress of 1893. The general use of the "Atlantic" type—4 : 4 : 2—of engine, and the recent extensive introduction of the four-cylinder compound system for high-speed passenger service were mentioned, as well as the increase in size and weight of goods engines. In boiler work, the wide fire-box has been applied to all classes of engines, and the back head is usually inclined. As to the spacing of tubes, a reduction of 83 tubes in similar engines reduced the heating surface by 25 per cent., but improved the circulation and consequently the efficiency of the heating surface. With wide fire-boxes the firing is often done without sufficient care or understanding, with consequent troubles due to leaks and excessive air admission. Only by the use of oil fuel or mechanical stokers will the continued growth of the locomotive be justified. Mr. Forsyth approved of the Walschaert valve motion, and referred to the great weight of parts of the Stephenson motion in recent engines:—Excentric, 212 lb.; excentric strap, 225 lb.; excentric rod, 125 lb.; link, 148 lb.; rocker arm, 248 lb.; transmission bar, 128 lb.; valve rod, 66 lb.; yoke, 90 lb.; valve, 211 lb. In spite of careful study broken main frames are still numerous, both with forged iron and cast steel frames. In regard to performance, an eight-coupled goods engine has hauled a train of eighty-six coal wagons, 5600 tons, 59 miles in five hours, over easy gradients. The four and six-coupled express engines of the Chicago and Alton Railway haul trains of nine and twelve cars, 500 to 675 tons, at 46 miles an hour booked speed.

Professor W. F. M. Goss said that the reason why the "American" type of engine, that is, the four-coupled bogie engine, or 4 : 4 : 0, is being superseded by other types of engines in express train service, is that it cannot be built to the proportions required for modern locomotives. The boiler has been raised to allow of a wide fire-box extending over the frames; the axle spacing has been increased to allow of a larger fire-box; and the wheel loads have been increased to increase the tractive power. But when all these had been carried to their limit, and still more power was demanded, a new type became a necessity. Thus we have new express engines of the 4:4:2, the 2:6:2, and the 4:6:2 types. The rest of the discussion related mainly to the comparative merits of the European and American—or Pullman—types of sleeping carriages. Compartment or corridor sleeping carriages are in use on several "crack" trains in the United States, but the ordinary Pullman arrangement is much more generally used. The "compartment sleeper" was invented in the United States by Mr. Mann, who also introduced it into Europe, but in America he could not compete successfully with Mr. Pullman, who eventually bought out the Mann patents.

Mr. Busse, locomotive superintendent of the Danish State Railways, presented a paper on the use of adjustable staybolts for locomotives. He had used a device to measure the displacement of fire-box sheets with the increase in temperature in the fire-box; a staybolt was used having an extension which passed through a gland and acted on the short end of a recording lever. He also uses adjustable stays to allow for the expansion of the fire box in heating and for the stretching of the tube sheet by re-rolling the tubes in place when the engine is repaired.

LIVE LOADS FOR RAILWAY BRIDGES.

A paper by Mr. H. W. Hodge, consulting bridge engineer, referred to the extensive replacement of bridges in the United States made necessary by the steady increase in weight of locomotives. On one railway the maximum weight on driving axles has increased from 15 tons in 1886 to 33 tons in 1903, and there has been a similar advance on most roads. It is estimated that axle loads can still be increased 15 per cent., or to about 35 tons, on each of four or five coupled axles without the engines exceeding the present clearance limits. As to train loads, the modern steel car with a load weighs 140,000 lb., or 4000 per lineal foot, but some roads, which carry iron ore, have wagons of 100 tons capacity, giving 7300 lb. per lineal foot, and one railway uses a train load of 7000 lb. per foot in designing its bridges. Mr. Hodges thought it would be unwise to design for anything less than 25 tons per axle and 5000 lb. of train.

In the discussion Mr. Reichmann, of the American Bridge Company, spoke of the growing tendency to the use of ballasted floors, instead of the open floors which have been so generally used for American railway bridges. He suggested that in designing bridges for open floors they shall be made strong enough to carry the extra dead load of a solid floor in the future. Mr. Robinson, bridge engineer of the Atchison Railway system, remarked that he is using solid ballasted floors, not only on steel bridges, but also on timber trestle bridges. The effect is to reduce the maintenance-of-way work on bridges from 12d. or 17d. per foot of line per year to about 3d. or 5d. per foot.

ELECTRIC *versus* STEAM TRACTION.

This important matter was the subject of a very brief paper by Mr. Alexander Siemens, M. Inst. C.E., on "The Substitution of Electricity for Steam as a Motive Power." The first part traced the early history up to the "first electric tram line in the Industrial Exhibition at Berlin in 1879." The electrification of lines in Italy and England was mentioned, as well as the Berlin experiments in high-speed electric service. The author concluded as follows:—"The conclusion to be drawn from the consideration of the relative position which steam engines and electric motors occupy at present, appears to be that it is more correct to regard the one as the supplement of the other, rather than to expect a complete substitution of electricity for steam as a motive power."

A more extended paper by Mr. J. G. White, of New York, discussed the various points of comparison, and largely to the advantage of electric traction, especially for suburban and interurban service requiring frequent service, high speeds, and frequent stops. At present, direct-current motors alone deserve serious consideration, and these should be supplied from direct-current generators for lines operating within a radius of six miles from the power station. Single-phase motors merit consideration where an infrequent service is operated, especially at considerable distances from the power station. If accounts of the development of the single-phase system are not too optimistic, the three-phase or other systems will have practically no status in future conversion studies. Within a few years many large American and European cities will have suburban lines converted from steam to electric traction, and some inter-urban steam lines are also likely to be converted, even where traffic is light, provided that a considerable increase in business is likely to result. As to general railway service, however, Mr. White agreed with Mr. Siemens, as shown by the following quotation:—"The conversion of main trunk lines and freight—goods—roads does not deserve serious consideration, except in rare instances where increased capacity is urgently needed, and is not otherwise obtainable at reasonable cost, or if operating through frequent or long tunnels."

ELECTRIC POWER.

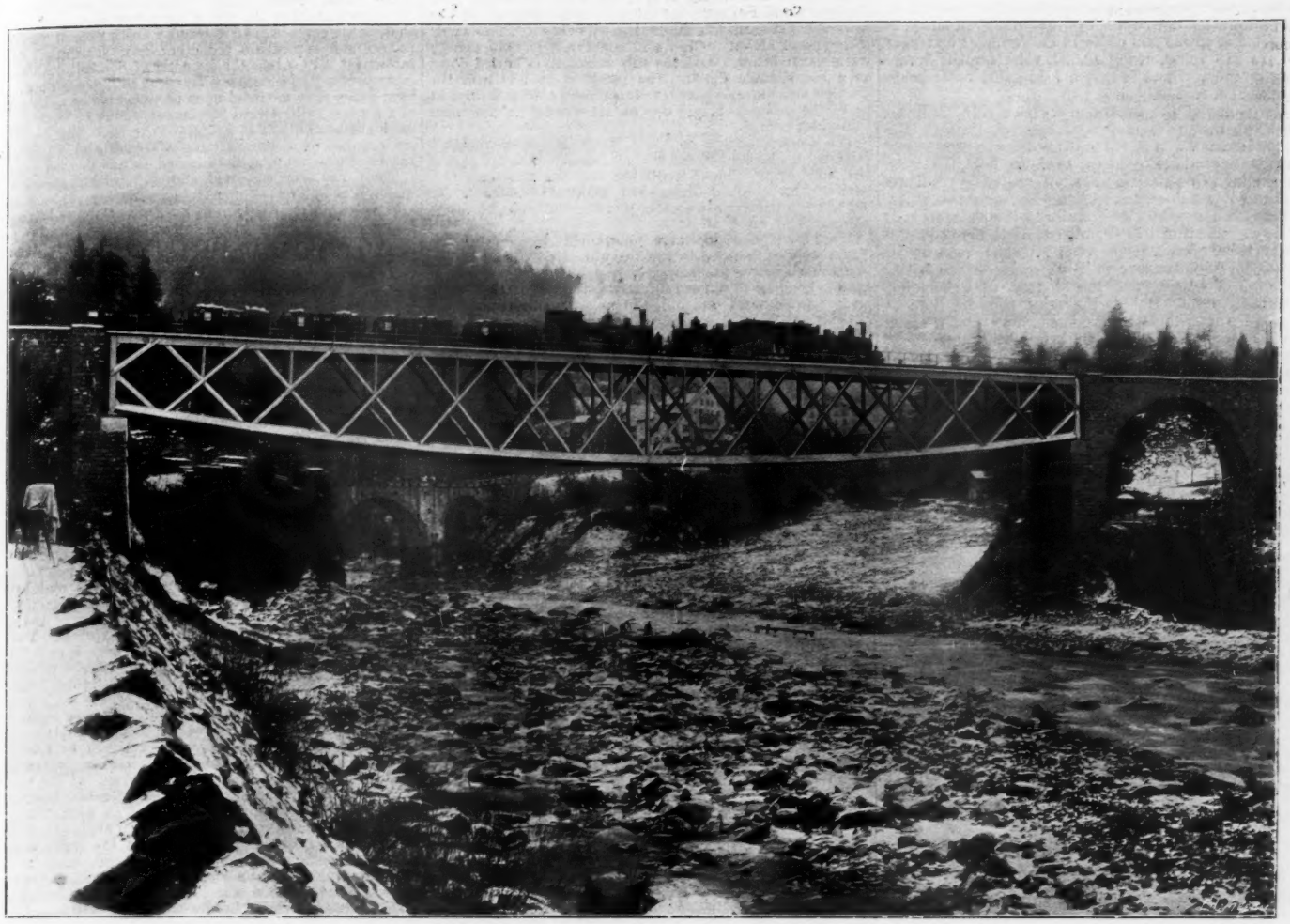
The paper by Mr. L. B. Stillwell was an interesting and comprehensive review of progress in the art of generating and distributing power by electricity, both as to specific apparatus and aggregations of apparatus. The most striking feature in this development is the marked increase in the use of alternating-current apparatus during the past decade, the total rated output of alternators now constituting more than 60 per cent. of the output of dynamos in central stations. Alternating current is very generally used for transmission, but converted to continuous current at sub-stations. If alternating-current motors equivalent to direct-current motors were available, the cost of apparatus would be greatly reduced, and there are promising developments in this line, two single-phase alternating-current motors having been devised in Europe and two in America. But American engineers have failed to realise and develop the possibilities of the tri-phase motor in traction work, as has been done by Ganz and Co. in Europe. The Niagara Falls Power Company is having six alternators built, each rated at 7500 kilowatts, but the most powerful steam-driven alternators are those of the New York elevated railways. These are of 5000 kilowatts, but can deliver 7500 kilowatts for two hours, with a rise of temperature not exceeding 55 deg. Cent. The largest continuous-current dynamos in America are of 2700 kilowatts. Improved insulation is largely responsible for the use of much higher potential than was possible ten years ago, but the improvement in efficiency of dynamos has been less marked.

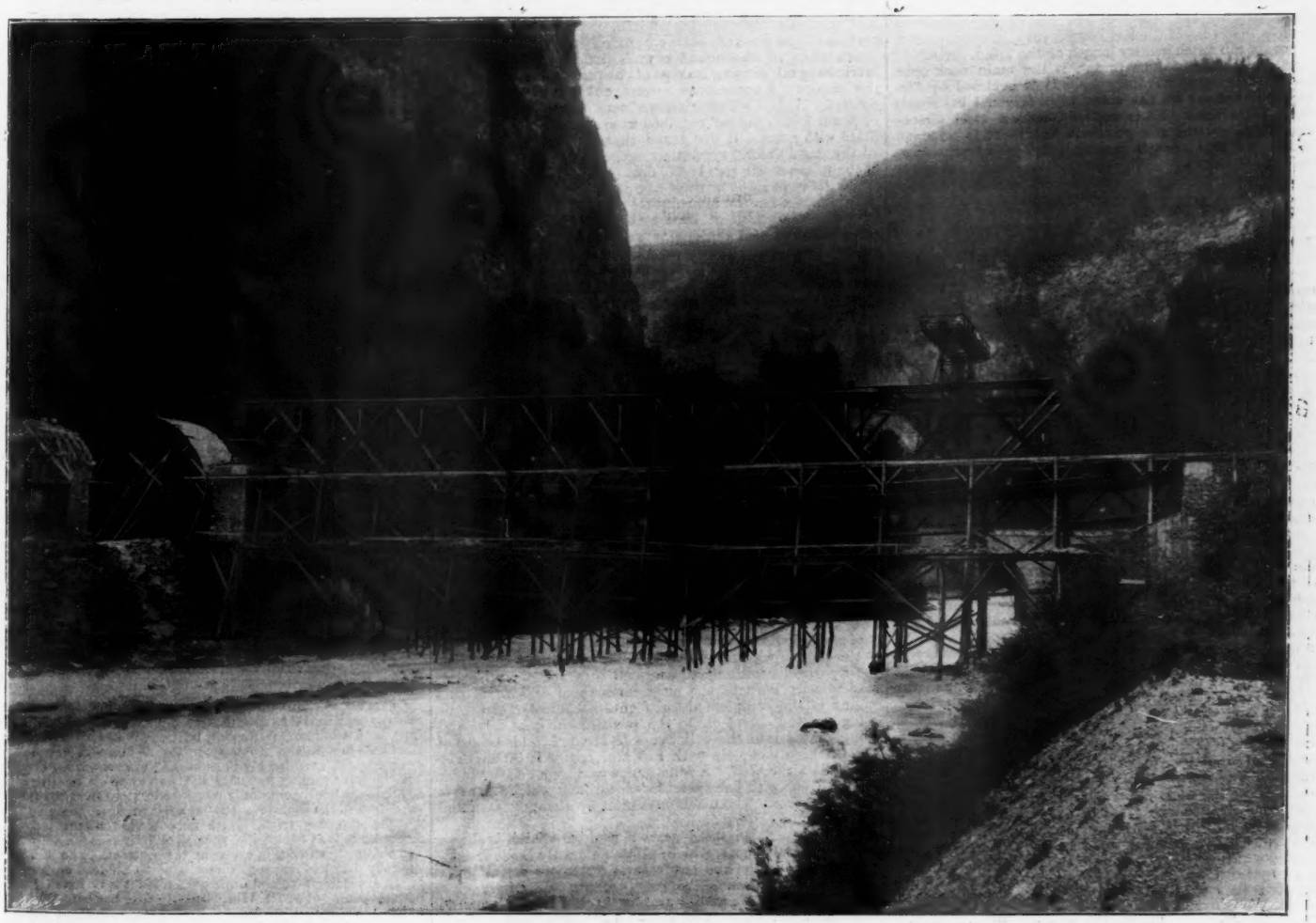
As to steam turbines, practice does not seem to support the claims in favour of economy of space occupied. The Chelsea power station of the London underground railways, with two decks of boilers, covers an area of 84,960 square feet, and is designed for ten turbine units of 5500 kilowatts, and two of 2000 kilowatts. The ground space, therefore, is 1·44 square foot per rated kilowatt. The power-house of the New York elevated railways, also with two decks of boilers, covers 85,072 square feet, and contains eight reciprocating engine units of 5500 kilowatts; the ground space, therefore, is 1·93 square foot per kilowatt. Vertical reciprocating engines occupy but a small fraction of the boiler area, and the spacing of the boilers usually fixes the spacing of either engines or turbines, and such advantage as the latter possesses in respect to floor space is

RAILWAY BRIDGE AT THUSIS

THEODOR BELL AND CO., KRIENS ENGINEERS

For description see page 511)





partially, if not wholly, offset by the increased size of the condensers. The claim for important fuel economy of the turbine has not been effectively substantiated in commercial service. On the other hand, it is comparatively small and light, and in time will be relatively cheap, while its high speed tends to reduce materially the cost of the direct-connected dynamo.

As to electric transmission, power to the amount of 10,000 kilowatts, developed by mountain streams, is transmitted to towns and cities in California at distances of 154 to 218 miles, using 40,000 volts for the transmitting circuits. Steel towers are in some cases being used instead of wooden poles.

In the course of the general discussion, Mr. Stillwell pointed out that with motors distributed through the train, gradients of 1 in 16 to 1 in 10 need not be prohibitive, the magnetic rail-brake being used to hold the train in descending. One electric railway is operating gradients up to 1 in 33 on a line 30 miles long between two cities, which are also served by a steam railway. The latter is kept down to a gradient of 1 in 50, and has a length of 50 miles between these points. Electric railways have lower expenses for maintenance of way, owing to the better distribution of weight, and the absence of unbalanced reciprocating parts. But at the same time he thought that a very substantial permanent way construction should be used. Referring to the paper by Mr. Siemens, he explained that the single-phase alternating-current motor requires nearly three times as much weight on the drivers for a given drawbar pull as is required by the three-phase motor, as the torque of the former varies with the alternations, and the motor exerts only a small effective drawbar pull in proportion to the weight on the driving wheels. The three-phase motor has a nearly constant torque. In this respect the electric locomotive has an advantage of 15 to 20 per cent. over the steam locomotive, owing to the unequal rotative effort of the two cranks on the latter.

H.M. FIRST-CLASS BATTLESHIP TRIUMPH.

We give on page 522 engravings reproduced from photographs by Symonds, Portsmouth, of H.M.S. Triumph, now with the Home Squadron assembled at Portland Harbour; together with an upper deck view forward, looking aft from the bows, which last shows the forward pair of 10in. guns, belonging to the main armament of the ship, protruding from their 9in. Krupp steel revolving shields, as well as the two foremost 7·5in. guns of the upper deck broadside, which can be trained axially. The steel revolving cranes, employed upon the ships Triumph and Swiftsure instead of booms for lifting in boats, are very prominent in these engravings.

The great length of the Triumph, 436ft. between perpendiculars, is very observable as one approaches her when afloat, and gives the impression of a somewhat low freeboard. Such, however, is not in reality characteristic of this war vessel. Her freeboard at the bow is 21ft. 6in., but as she has a rising sheer aft, the freeboard at the stern is 19ft. 6in., and the height of the centres of the two 10in. guns forward above the load water-line is 23ft. 6in., the corresponding centre height aft being about 2ft. less. The height of centres of the main-deck battery 7·5in. guns is 13ft. 2in., or rather more than that of the main-deck battery 6in. guns of the King Edward VII., making, however, the angle of heel required to bring the centre of the muzzles to water-level rather less than that of the last-named ship, in consequence, of course, of the much greater length of the 7·5in. guns.

A striking feature of the Triumph is the main deck open battery containing ten 7·5in. guns. It is enclosed by 7in. Krupp steel armour on the sides, with diagonal bulkheads of 6in. steel armour at the ends. One-inch steel screens divide off the several gun positions, but there is no longitudinal web of this strength isolating the guns in the rear, which is to be regretted. The ammunition is brought up to each separate position by electric hoists, which can work with great rapidity, and are an immense improvement on the old whip hoisting gear.

The guns are lifted up to the overhead railway to be run in for housing inboard, when the vessel is at sea, by a small hydraulic engine, this replacing the differential blocks and hand chain gear for the 6in. guns of Admiralty vessels. The ammunition also has a hoist for carrying the projectiles into position, but, as a matter of practice, we understand that the bluejackets prefer to lift the 200-pounder shell by hand, two men lifting it, one at the point, another at the base. Telescopic sights are placed upon the left side of the guns, which give the most admirable results in firing practice. The range covered by them is from 12,000 to 14,000 yards, but the most effective range of the 7·5in. gun is rather within those limits. It is needless to say that, with ten guns of so large a size, and the mess tables, and all the fittings and gear of the enclosed battery, the space is rather crowded; but the tables fold up, so as to economise room, and the covers of the ammunition hoists are compact and well placed. The gun positions themselves have plenty of room. The number of rounds fired from each gun per minute gives an average of five without any difficulty, and the officers on board speak well of the 7·5in. gun, as being quite as handy as a 6in.

The 14-pounder guns on board are practically similar to the ordinary 12-pounder gun employed in our Admiralty vessels, and will, we understand, take the same ammunition. The 6-pounder gun is a speciality, with a breech screw of very simple character, widening out in diameter from the breech face to the interior of the gun, so that it could not possibly be blown out. It has a lever action, somewhat similar to that of the ordinary 12-pounder. Pompoms are employed in the tops, and are not regarded with equanimity by the bluejackets, owing to their disagreeable noise and habits of jumping. This was found to be the case in South Africa, where many of the guns were put out of action by the smashing of the pivot and jaws by which the gun was secured to the carriage. On the bridge of the Triumph the noise is distracting when these guns are fired.

The cranes for lifting boats in and out are most serviceable. A steamboat weighing 50 tons can be picked up, swung round, and dropped into the water as easily as a dingy, and the hang over is very far reaching. It is true that they present a larger surface to the fire of an enemy than an ordinary boom, but they are in duplicate, in case one should be disabled.

Five large dynamos supply the electric power for all the requirements of this ship, and an infinity of motors All the ammunition hoists are operated by electricity, and many of the other movements on board are similarly worked.

There is rather a deficiency of power in the ventilating department on board, the fans employed and the ventilating trunks being of smaller size than those usually supplied to Admiralty-built vessels. In point of fact, their absence in many places where usually found in our battleships is most conspicuous. The result is that below the armoured deck the heat is intense, and what this part of the ship will be like when she is stationed in the Tropics—if ever—it is impossible to conceive. Even in this cool country it is unpleasantly warm down below. And the only workshop is buried down at a considerable depth. The result of this is that the portable and movable part of the repertoire of tools is brought up to the main deck, and repairs are effected in this more salubrious climate.

The accommodation on board the Triumph is excellent. Bath-rooms, lavatories, and a capital smoke-room are part of the ward-room officers' attributes, and the gun-room is a perfect palace. In the Chilian navy many of the officers, who are in the ward-room in the Navy of Great Britain, belong to the gun-room mess.

Whilst on board we were shown the spot where the Triumph was rammed by the heavy Trinity barge. It was beneath the counter. Happily, however, the 3in. armour plate extending to the stern received the barge's steel stem as it drove inward, and only the upper strake of ordinary plating was crushed up. The 3in. armour plate saved the ship. The Triumph can keep up her 20 knots with comparative ease, and has done so.

THE STANLEY SHOW.

The prediction which we ventured to make some months ago in The Engineer, that the public would next season be able to purchase bicycles built by a firm of high standing for £6, has already been verified. At this year's cycle show, which is being held under the auspices of the Stanley Show Committee, at the Agricultural Hall, Islington, practically the only feature worthy of note in connection with the pedal cycle is the great reduction in prices which has taken place. No new designs are to be seen, nor would it appear to be a suitable opportunity to introduce fresh patterns, when such keen competition renders strict standardisation the only way for manufacturers to show a profit. The character of the cycle trade has undergone a remarkable change since the introduction of the automobile, and most of the leading makers have set themselves to solve the problem of producing what has been not unsuitably termed "the poor man's motor car." The most noteworthy feature in connection with the new self-propelled bicycles is the tendency shown by the designers towards a reduction in weight and engine power, with the result that a much more elegant combination is produced. It may also, perhaps, be inferred that the motor cycling public is now content with much more moderate speeds than those which have recently been so prevalent. A cycle with a 3 horse-power engine may now be had, weighing altogether less than 1 cwt. The power in almost every case is derived from the petrol motor, and on the whole the workmanship displayed leaves little to be desired. It would seem, however, that the perfect internal combustion engine for this class of work should have better provision for cooling the cylinder than merely radiating gills. If water cooling is inconvenient on the bicycle, the provision of a fan should be a comparatively simple matter, without adding materially to the weight. It has been found in practice that, although the front side of the engine is kept cool enough when the bicycle is in motion, the hindmost surface of the cylinder shows a much higher temperature. Overheating of the cylinder walls tends to vaporise the lubricating oil, causing leakage of gas past and undue wear of the piston. Experiments carried out some time ago by Professor H. L. Callendar showed very conclusively the gain in power which can be obtained from a small bicycle motor fitted with a fan. It was found that by running the engine on the stand at 2000 revolutions without fan the temperature of the exhaust side rose to 570 deg. Cent.—a dull red heat—while the inlet side remained comparatively cool. After the provision of a fan the temperature on the exhaust side rarely exceeded 400 deg. Cent., even with the throttle full open, the spark retarded, and the engine running continuously. The fan was secured to the fly-wheel, and a suitable case conducted the air blast on to the engine. As the bicycle was not in motion it was decided, in order more nearly to approach the actual conditions on the road, to fit a second fan to blow on to the front of the engine, and it was then shown that with both fans at work the exhaust seldom exceeded 300 deg. Cent. or the inlet valve 70 deg. Cent. It might be objected that the gain is purchased at the expense of the engine power, but it was found that not more than $\frac{1}{10}$th horse-power was required to drive a fan which gave a blast of 25 miles per hour. With such figures before them motor cycle makers will do well to give this method of cooling close attention.

A new system of water cooling for motor cycles is shown by the N.S.U. Cycle and Motor Company, of Hatton-wall, London. The engine is of the vertical type, 4½ horse-power, and the radiator is rectangular in section, and composed of a large number of tubes on the honeycomb principle. It is hung on the top tube of the cycle, and is provided at its rear with two fans, which are driven by a round strap from the engine crank shaft. The radiator carries about a quarter gallon of water. One of the greatest novelties in the show is Howard's patent motor bicycle, the frame of which is practically the same as used on a standard safety machine. The motive power is supplied by a single-cylinder petrol engine of the horizontal type, and fairly large fly-wheel bolted to the tube in which the saddle pillar fits, and a belt from the fly-wheel communicates motion to a pulley on the rear road wheel. Perhaps the most remarkable feature of this engine is the complete absence of a carburetter, the spirit being sprayed direct on to the stern of the inlet valve and being drawn into the cylinder with the air. The weight of the machine complete with a 3 h.p. engine is 90 lb. The engine is air cooled. A wide flange cast round the cylinder is drilled out with horizontal holes, through which the air is allowed to pass. The machine is built by Messrs. Mason and Brown, of Leicester.

Amongst variable speed gears a working exhibit is shown of Low's variable gear, which, although rather crude in construction, is simple, and has features which are desirable for motor car purposes. The gear consists essentially of a pulley, having two parallel grooves in which two separate belts can work, which is mounted on a countershaft between the engine and road wheel. The motor drives the twin pulley by means of a V belt running in one of the grooves of the latter, and the motion is transmitted to the road wheel by a second V belt running in the other groove. The twin pulley consists of a barrel mounted on ball bearings, and carrying at each end a fixed flange. Upon the barrel there slides a sleeve, which carries fixed upon it a third flange, whose outer faces form, with the inner faces of the two former flanges, the two V-shaped belt grooves mentioned above. This central flange is capable of movement in a direction parallel to the axis of the pulley, and it will be seen that, as it moves along, it recedes from one of the outer flanges and approaches the other one. The effect of this movement is to reduce the diameter of one belt-path and to correspondingly increase the diameter of the other one. The twin pulley is so mounted upon the machine as to be capable of a forward or backward movement, either by sliding along guides or by swinging in a frame or carrier. This movement is controlled by a lever, having a trigger and quadrant by means of which it may be retained in any desired position.

The pulley being mounted, and with belts in position, the action is as follows:—Supposing the machine to be running, say, on any intermediate gear, the centre flange—being quite free to move sideways in either direction—will be in such a position that both belts are running at even tension. Now, if the lever be moved so as to move the pulley forward, the increased tension of the rear belt will at once cause the centre flange to move over towards the other belt, which, owing to its reduced tension, will allow the centre flange so to move over, until equilibrium is once more restored and the belts are running evenly as before; but the gear will have been lowered.

If the pulley be moved backward the gear will be raised, always in exact proportion to the distance through which the lever has been moved.

Spring wheels for motor cars and cycles still have attractions for the inventive genius. Either from lack of knowledge or excess of enthusiasm, or a combination of the two, the inventors of these devices frequently state that by interposing springs somewhere in the wheel between the rim and the axle, all the good qualities of the pneumatic tire can be obtained without the attendant disadvantages. Of course, this is not the case, since the solid tire cannot ride over uneven surfaces without lifting the wheel, if not the axle. The pneumatic tire, on the contrary, interposes an elastic cushion between the irregular surface of the road and the wheel itself, and this is effected by a continuous spring of compressed air extending round the periphery of the wheel. Thus no work is done in compressing springs. That the pneumatic is unreliable for motor car work is only too well appreciated, but many of the spring wheels which have been introduced only replace one source of trouble by another almost equally bad. Perhaps one of the best attempts to produce a satisfactory elastic wheel has been made by the inventor of the Hallé spring wheel. The principle on which this wheel is constructed may be explained by taking two parallel rulers and connecting them together, so that there are three rods joined by parallel links. If the two side members are held forcibly apart a considerable pressure may be sustained by the middle member. The result is that, as the pressure increases, the links form an angle and draw the side rulers towards each other against the outer pressure, which pressure, when the strain is released, tends to bring the three rulers into the original position again. The main principle of the Hallé wheel is as above described, but the side rulers are replaced by discs, and the centre ruler by a ring hub, while the links are provided with universal joints at either end. The side discs slide on tubes on the axle, and are forced apart by very powerful spiral springs. The universal joints allow the ring hub, to which the spokes are attached, to become excentric to the axle in any direction, but as the side discs must always remain at right angles to the axle, the ring hub, which must remain parallel to the side discs, must always remain at right angles to the axle also; no matter what position of excentricity it may assume. When weight or shocks are received by the wheel the side discs are drawn together by the links, forming an angle as the ring hub becomes excentric to the axle. Besides the main horizontal springs, the Hallé wheels are fitted with auxiliary resilient springs, either elliptical or volute. The function of these springs is to provide increased comfort of travelling. These wheels are made by the Hallé Spring Wheel Syndicate, Limited, Tunnel-avenue, East Greenwich.

Although there is an extensive display of motor cars, there is not much which calls for notice, most of the exhibits being already familiar to those of our readers who are interested in automobilism. The Rover car, of which an illustrated description appeared in The Engineer recently, is the greatest novelty. Practically the only modification of note which the builders have found necessary since the Hereford trials is the introduction of a cast aluminium truss midway across the frame. This will serve to give greater rigidity to the car. We understand, too, that Mr. Lewis has placed the balls forming the bearings for the half-time shaft in a cage to prevent a repetition of the Hereford disaster in case of the fracture of a ball. The Rover automatic carburetter is also shown, and gives the impression that it will meet the requirements of an automatic appliance. Humber's exhibits include a new car of elegant and original design. It is described as an 8-10 horse-power car, and is propelled by a four-cylinder engine, the dimensions of the cylinders being 3in. by 3½in. The transmission gear is of the usual pattern. The car is extremely reasonable in price, and should have a ready sale. It only weighs 11 cwt.. and, considering its seating capacity, would appear too light for touring purposes. It would, moreover, appear from previous experience that the multiplication of the cylinders for such low powers is not always an unmixed blessing.

Dredger for the Indian Government.—The dredger Manar, recently constructed by Messrs. Wm. Simons and Co., Limited, Renfrew, for the Indian Government, has undergone her official trials on the Clyde in a satisfactory manner, the results obtained being, in every respect, considerably in excess of the contract requirements. The bucket-dredging capacity was proved to be at the rate of 600 tons per hour, being fully 50 per cent. more than the quantity stipulated in the contract; the material dredged being stiff clay. At the steaming trials, which were made on the Admiralty measured mile at Skelmorlie, a speed of fully nine knots per hour was obtained, which is in excess of the contract. The Manar was specially designed and constructed to carry her load on a draught of not exceeding 8ft., and during the trials it was found that the draught came out at 7ft. 11in. This dredger has been constructed under the direction of Messrs. Rendel and Robertson, consulting engineers to the Indian Government, who were represented at the trials by Mr. Seymour B. Tritton, M. Inst. C.E., and Mr. E. H. J. Gaze.

RAILWAY MATTERS.

THE stations of the Paris Metropolitan line No. 3 are better lighted, the exits wider, and the principal booking-offices more spacious than those of lines 1 and 2.

SANCTION has been accorded to the provision of Warner's outers, homes and starters, in connection with the working of signals to trains running through the stations on the double line of the East Indian Railway between Sitarampur and Mogalserai station.

THE Dover Corporation decided on Tuesday to take over the powers of the River Light Railways Syndicate, and to extend their electric tramway system to the suburb of River, at a cost of £21,000. The work is to be carried out with all speed, to find work for the unemployed.

THE Berlin correspondent of the *Standard* states that Herr von Budde, Minister of Railways, will preside shortly over a conference which has been called to discuss the practicability of an electric railway between the capital and Hamburg. The difficulties before the scheme are reported to be of a financial rather than a technical character.

THE London and North-Western and Brighton and South Coast Railway Companies have arranged for the through service between Liverpool, Manchester, Leeds, Birmingham, &c., and Brighton, Eastbourne, Hastings, and other South Coast stations to continue running on every week day during the whole of the winter period. It was at first intended that this service should cease on the 31st December and not be resumed until the summer

IT is stated that at High-street, Kensington, Station, the joint property of the District and Metropolitan Railway Companies, it is proposed to pull down the buildings at present occupying the frontage, and in their place to erect business premises, intersected by a central arcade of shops 100ft. in length. It is expected, says the *Railway News*, that Gloucester-road and South Kensington stations, which are also the joint property of the District and the Metropolitan Railway Companies, will in the near future receive somewhat similar treatment.

A TRACK-LAYING record of 9320ft. in one day has been made on the San Pedro, Los Angeles and Salt Lake Railway. This is a good record, but, according to *Engineering News*, does not come up to the work on the Canadian Pacific Railway in 1882, when the average for six months was 2·47 miles per working day, the monthly averages being from 1·47 to 3·22 miles per working day. On the Minneapolis, St. Paul and Saulte Ste. Marie Railway extension across North Dakota in 1893, the average was three miles per day, while the regular force on one or two occasions laid over four miles of track in ten hours.

IN anticipation of the approaching commencement of their new steamship services between Goole and Hull, and Hamburg, Antwerp, Ghent, and other continental ports, the directors of the Lancashire and Yorkshire Railway Company have deputed a party of their leading officials, comprising, amongst others, Mr. J. A. F. Aspinall, general manager; Mr. C. W. Bayley, chief traffic manager; and Mr. J. Wharton, goods manager, to make a tour of inspection on the Continent, and to report upon the transportation methods and machinery of several of the principal Belgium and German railway systems and harbour authorities.

AS a result of successful trials of an electric locomotive on the New York Central Railroad, near Schenectady, New York, recently, forty engines of the same type will be put into service on the suburban branches of this line north of New York. The normal capacity of these locomotives is to be 2200 horse-power, or 50 per cent. more than that of the locomotive which draws the Empire State express, and it has been demonstrated that the electric engines can haul a nine-car train at 60 miles or more per hour. The experimental line on which the trial was made is four miles long. At crossings the third rail is interrupted, power being supplied by an overhead conductor.

IN the ensuing session of Parliament the South-Eastern and London, Chatham and Dover Railway Companies and their managing committee intend to apply for an Act authorising them to widen the South-Eastern Company's line at Ashford, Kent; to extend the time for the compulsory purchase of lands and for completing works authorised by the South-Eastern Company's Acts of 1889 and 1898, the Chatham Company's Acts of 1879, 1892 and 1898, and the South-Eastern and Chatham Company's Acts of 1900 and 1902; and to provide for the purchase and transfer of the Sheppey Light Railway by and to the two companies, the managing committee, or any of them.

THE St. Louis Railway Station has thirty-two tracks running into it, and 278 daily trains arrive and are despatched. The interlocking signal plant is one of the largest in the world. It is worked on the electro-pneumatic system, and controls 1835 train movements daily. There are also thirty-five hydraulic lifts and several subways for luggage, pneumatic tubes for baggage-checks and messages, and many other conveniences, power for which is furnished by four 350-kilowatts and two 200-kilowatts generators, also two 200 horse-power air compressors, in a power house 146ft. long by 99ft. wide. The arrangements for coaling and watering the locomotives are also very complete. Fifteen engines can be coaled simultaneously.

THE Great Northern Railway Company's assessments in the Edmonton Union, in respect of their main line and suburban branches and stations near London, were recently raised by the Assessment Committee from £51,036 to £66,567. The company appealed against the assessments, and the matter was referred to the chairman of the Middlesex Quarter Sessions. After a hearing lasting eighteen days, the arbitrator has issued his award, in which the assessment is reduced to £42,940. The Union is ordered to pay the whole of the costs in respect to the part of the inquiry relative to the receipts and expenses, and each party to pay its own costs of the portion of the case occupied in respect of the application of the two decisions referred to.

LAST week Sir Herbert Jekyll heard objections to the confirmation of the order passed by the Light Railway Commissioners, for a light railway from Snowdon to Bettws-y-Coed, a distance of thirteen miles. The proposed railway—2ft. gauge, worked electrically—was opposed by the National Trust for Places of Historic Interest or Natural Beauty, the Co-operative Holiday Association, the Alpine Club, representatives of colleges at Oxford and Cambridge, and memorialists from all parts of the kingdom. The ground taken was that the beauty of the Snowdon district was so exceptional and its attractions for a large number of visitors so great as to deserve protection from a railway. Sir Herbert Jekyll said the Board of Trade would consider the objections and give a decision shortly.

IN the forthcoming session of Parliament the Central London Railway Company will apply for an Act empowering it to make a railway (No. 1), commencing at the generating station in Wood-lane, Shepherd's Bush, and terminating by a junction with railway No. 2, under Goldhawk-road, near Bamborough-gardens; a railway (No. 2), commencing under Uxbridge-road, at its junction with Goldhawk-road, by a junction with the company's existing line, and terminating under Goldhawk-road; a railway (No. 3), commencing under Uxbridge-road, by a junction with the company's existing line, and terminating at the end of railway No. 2; a railway (No. 4), commencing by a junction with railways Nos. 2 and 3 at their common point of termination, and terminating under Leadenhall-street; a railway (No. 5), commencing at the end of railway No. 4, and terminating under Old Broad-street, at the end of the company's existing line; and various subways.

NOTES AND MEMORANDA.

THE metal palladium, like platinum, is hard, ductile, malleable, and unaffected by chlorine and hydrogen sulphide gases, but is cheaper, being found quite abundantly.

THE fumaroles, or steam-jets, issuing from the cone of Mount Vesuvius have been found to deposit various ores, including cinnabar, realgar, hematite and copper and lead chlorides.

THE United States Navy Estimates for the year ending June 30th, 1906, amount to £22,906,127, an increase over the figures of the previous year of £3,474,489. Of this total £6,082,166 are for construction and machinery and £2,800,000 for armour and armament.

THE borough engineer of Kensington, as a result of experiments with different dust-laying fluids, has reported to his council that these are unsuitable for use in London, and that their adoption at the present price for oils would at least double the cost of the work of road-watering in Kensington.

OUT of 138 towns and cities in Germany with over 20,000 inhabitants, 55 per cent. are supplied with ground water, 33 per cent. with springs or springs and ground water together, and 15 per cent. springs and filtered river water, partially supplemented by ground water and partially by impounded surface water.

THE important part which the rivets play in the construction of modern steel steamships is well illustrated by the fact that in the new Cunard liner Caronia, the largest ship ever constructed in Great Britain, no less than 1,800,000 rivets were used, the total weight represented being about 600 tons. The greater part of the riveting work was done by hydraulic power.

IN pouring chrome steel—1 per cent. chromium—into moulds, there is frequently formed a slight slag, or oxide, which would seriously injure the strength of the casting. To remedy this the workmen throw into the crucible a bit of metallic aluminium as large as a walnut. As the aluminium burns instantly with a blinding flash, it appears that its service consists in reducing some iron oxide that has been formed.

HIGHLY successful experiments with the British submarine B1 are said to have been completed at Barrow-in-Furness. This submarine is of a new type, and much larger than any submarines yet built. She was taken out to deep water outside Barrow harbour, and there went through a long series of evolutions with the greatest possible success and without hitch. She remained under water at one time for three hours, but she ultimately floated to the surface some two miles away, and reported she could have stayed down a much longer time.

HIS Majesty's new cruiser Topaze, the first of a new type of fast third-class cruisers designed to steam 21¾ knots per hour, has been reported ready for delivery from the works of Messrs. Cammell, Laird and Co., Birkenhead, where her keel plate was laid on August 14th, 1902. The Topaze, which will be the fastest third-class cruiser in the Royal Navy in commission, has a length of 360ft., a breadth of 40ft., and a displacement of 3000 tons, her machinery being of 9800 horse-power, and supplied with steam from Laird-Norman water-tube boilers.

THE new United States armoured cruiser Colorado recently made her trial trip near Boston, and maintained an average speed of 22·26 knots, making 88 knots in about three minutes less than four hours. The Colorado is 502ft. long, 69ft. 6¼in. beam, with a trial displacement of 13,680 tons. Her engines are of the four-cylinder vertical inverted direct-acting type for twin screws, and give 23,000 indicated horse-power. There are twelve Niclausse boilers and four smoke stacks. The maximum speed developed was 23·33 knots, which was maintained for 6·6 hours.

THERE has just been completed a dredger, built to the design of the Mersey Dock Board by Messrs. Ferguson Brothers, of Port Glasgow, which is claimed to be the largest in the world. Her measurements are 200ft. long, with a 42ft. beam, and she can dredge to a depth of 56ft below water level, and end-on to a wall to a depth of 48ft. She is capable of raising 1000 tons of hard material per hour. The mechanical equipment includes a long projecting ladder bucket arrangement, by which it is possible to clean a dock or quay wall right up to the face at a depth of 48ft. The new dredger is named the Vulcan.

A LOG cofferdam, 140ft. long at the base, 250ft. at the crest, 50ft. high, and 160ft. in width at the base, is being constructed on the Clackamas River at a point near Cazadero, Ore., to divert the river water into a power canal during the construction of a permanent concrete dam 1000ft. below it. The upstream slope of the dam will be 3 to 1. There will be seven cribs in the direction of the stream flow, and the foundation logs for starting the cribs are no less than 140ft. in length, reaching from bank to bank. The contents of the dam, filled with stone from the adjacent banks, is about 35,000 cubic yards.

ESTIMATES recently prepared in the United States Bureau of Navigation show that when all the ships now building have been commissioned the navy will need for the manning of all its vessels about 2087 officers and 62,368 men. This is more than twice as many men as the law provides for to-day. It is, says the *Army and Navy Journal*, an illustration of the uneven way in which Congress has been building up the navy in the past, appropriating for new ships, under pressure from the shipbuilding interests of the country, and refusing to listen to the appeal of the navy department for corresponding increase all along the line.

INSTEAD of impulse wheels, turbines are about to be adopted in a high-head water power plant for the Central California Electric Company on the American River. The head is 2100ft, and the project is to take the discharge from the company's plant at Alta through a canal to a place where the head mentioned can be obtained by using steel penstocks. The interesting feature of the plans is the use of turbines rather than impulse wheels, which are generally employed in high-head power developments in the West. It is understood that the wheels will be 4ft. or 5ft. in diameter and run at 750 revolutions per minute. There are no turbines working under very high heads in America.

THE *American Manufacturer and Iron World* states that there are in America at present time about fifty sand lime brick plants with a total capacity of approximately 1,000,000 bricks a day. The experience of these plants indicates that sand lime bricks can usually be manufactured at a cost below that of common clay bricks. When, however, sand lime brick is desired, equal to the fine clay front brick, the cost of production naturally is increased beyond that of common clay bricks. Sand lime bricks have been in use long enough, both in America and in foreign countries, to prove that when properly made they have sufficient strength, and sufficient water and weather-resisting qualities to make them a safe building material.

THE Admiralty have decided to employ more modern cruisers on gunnery instructional duties at the home ports, and have directed the Immortalité, Narcissus, and Undaunted, which belong to the old type of "belted cruisers," to be replaced by cruisers of the Grafton type, which are larger, faster, and better equipped. The Endymion, which pays off at Chatham on November 30th from the Channel Fleet, is to be prepared to replace the Immortalité at Sheerness; the Grafton, late Commodore's ship on the Pacific station, and which is on her passage to England, is to relieve the Narcissus at Portsmouth; and the Theseus, late of the Channel Squadron, which pays off at Devonport on November 30th, is to succeed the Undaunted at Devonport.

MISCELLANEA.

IT is stated that there are at present fifty-three idle steamers in the Tyne.

AT Elswick, on Tuesday afternoon, a new addition to the British fleet of scouts was launched, called the Attentive. The vessel is fitted with ten 12-pounder quick-firing guns and eight 3-pounder quick-firing guns, besides two torpedo tubes.

THE Great Mount Morgan gold mine in Queensland bids fair to become a producer of copper also. It is stated that a million tons of ore, estimated to contain 3·5 per cent. copper and 8 dwt. gold per ton, have been proved. A smelting and converting plant is to be erected.

AS a result of increase in the size of vessels engaged in the St. Lawrence trade this year, it is expected that the port of Montreal will, for the first time in its history, reach the 2,000,000-ton mark in aggregate of shipping. The total tonnage to November 1st was 1,700,000 tons.

ACCORDING to the approximate traffic returns for October, the Manchester Ship Canal receipts last month amounted to £35,698, as compared with £33,114 in October last year. For the ten months the receipts have totalled £331,676, or £17,288 more than in the corresponding period of last year.

DURING the six months ended September the Bournemouth Municipal Electricity Works generated 869,227 units, an increase of 112,305 over the corresponding period last year. The works costs were 1·0461d. per unit generated, against 1·1188d., and the total costs were 1·6674d., against 1·8058d. in 1903-4.

ACCORDING to returns published by the United States Commissioner of Navigation, 78 vessels, aggregating 14,024 tons gross, were built in the United States last month, of which 35, of 9761 tons, were wooden sailing ships; 41, of 2735 tons, wooden steamers; 1, of 331 tons, a steel ship; and 1, of 1197 tons, a steel steamer.

A LARGE number of men employed at the Bloomfield Ironworks, Tipton, which have been in existence for over a century, received notice on Saturday to terminate their engagements, it having been decided to dismantle the works, to enable the proprietors to get a valuable seam of thick coal, known to be under the works, which mining experts estimate at nearly a million tons.

DISPATCHES have been received at the Board of Trade from his Majesty's Consul-General at Christiania, reporting that the Royal Norwegian naval authorities invite tenders for 350 dozen files and rasps. Tenders marked "Anbud Paa file" will be received up to 14th December. Apart from the usual Customs duties, a preference of from 10 to 15 per cent. is given to Norwegian manufacturers.

THE value of the natural gas production in the United States last year is estimated at £7,163,072, which is an increase of 16 per cent. over the previous year. There were large gains in Pennsylvania, in Ohio, and in West Virginia. The volume of the gas produced is estimated at 238,769,067,000 cubic feet. Its heating value would equal approximately that of about 12,000,000 tons of good bituminous coal.

A GOVERNMENT Bill was introduced into the Reichsrath on Tuesday by which owners as well as drivers are made responsible for injury to persons or property by their motor cars. Responsibility can only be avoided by proving that the accident was due to unavoidable circumstances, or to the fault of the person injured. It will, however, not be regarded as an unavoidable contingency if the accident is attributable to inferior machinery or a defect therein.

A TELEGRAM from the New York correspondent of the *Times* states that the American Federation of Labour, the largest and most influential labour organisation in the United States, at its convention at San Francisco, unanimously adopted a proposal in favour of the exclusion of Japanese from America. The Federation desires not only the same treatment of Japanese as that which Chinese now receive in this country, but also their exclusion from every American insular possession.

ALTHOUGH Liverpool now contains the largest oil mills in the country, viz., the African Oil Mills at the south end, it is probable that in a short time another one on even a larger scale will be erected, also at the south end. This mill will be designed for dealing principally with West Coast of Africa products, of which palm kernel and copra are most important factors. At the present time vast quantities of these are shipped from the West Coast to the Continent, and there dealt with.

ACCORDING to the Berlin correspondent of the *Times*, the Krupp Works at Essen have so many orders in hand that in the heavy gun department the men are working in double gangs. Some 2000 additional men have been taken on at Krupp's since April, so that now about 27,000 hands are employed in the works. Moreover, it may be noted that the number of men employed on and before April 1st was some 2000 in excess of the average number employed last year. Krupp's ammunition factory at Witten is also working at high pressure.

THE Board on Wireless Telegraphy has finished its tests, and submitted to the United States Navy Department its report, which will not be published. It is understood that the Marconi Company, which declined to participate in the recent tests, has now assumed a different attitude. The Board, says the *Army and Navy Journal*, is not inclined to conduct a special test for the Marconi Company, in view of the fact that the conditions of the test were carefully explained and outlined months ago, and were acceptable to many wireless companies.

ACCORDING to returns of vessels totally lost, condemned, &c., from 1st April to 30th June, issued by Lloyd's Register, 120 vessels, aggregating 153,626 tons, were lost in the three months, of which 23, of 32,739 tons, were owned in the United Kingdom; 13, of 9980 tons, in Norway; 4, of 9861 tons, in Germany; and 6, of 9187 tons, in Russia. Of the countries owning over 1,000,000 tons of shipping, this country lost in the quarter 0·21 per cent. of the tonnage owned, against 0·29 per cent. by Germany, 0·31 per cent. by the United States, 0·48 per cent. by France, 0·58 per cent. by Norway, and 0·74 per cent. by Italy.

AT San Luis Potosi, Mexico, they have a number of lead furnaces converted into matting furnaces by filling the crucible and putting in a sloping hearth of fire-brick. According to the *Engineering and Mining Journal*, the crucible is about 2ft. deep below the tuyeres in front, and a tap-jacket is put in on the side near the corner of the furnace, and high enough above the floor to admit a slag-pot under it, with slightly depressed floor space immediately around the tap. These furnaces are used for the concentration of matte made in the lead furnaces, whatever metallic lead there is produced coming out with the matte and being recovered on the dump.

AN important contract for the supply of constructional steelwork to be used in the erection of new docks in South America was recently obtained by the Patent Shaft Company, Wednesbury, the raw material being about 4000 tons. In order to avert the necessity of the employers obtaining the heavy plates from South Wales, they asked the workmen to consent to a revision of wages, as the plates could be manufactured at Wednesbury. It was on Saturday afternoon ascertained that the workmen, after interviewing the Wages Board, had declined to comply with the employers' request, the result being that the employers will be forced to get the material from South Wales, and £5000 less wages will be earned at Wednesbury.

HIS MAJESTY'S FIRST-CLASS BATTLESHIP TRIUMPH

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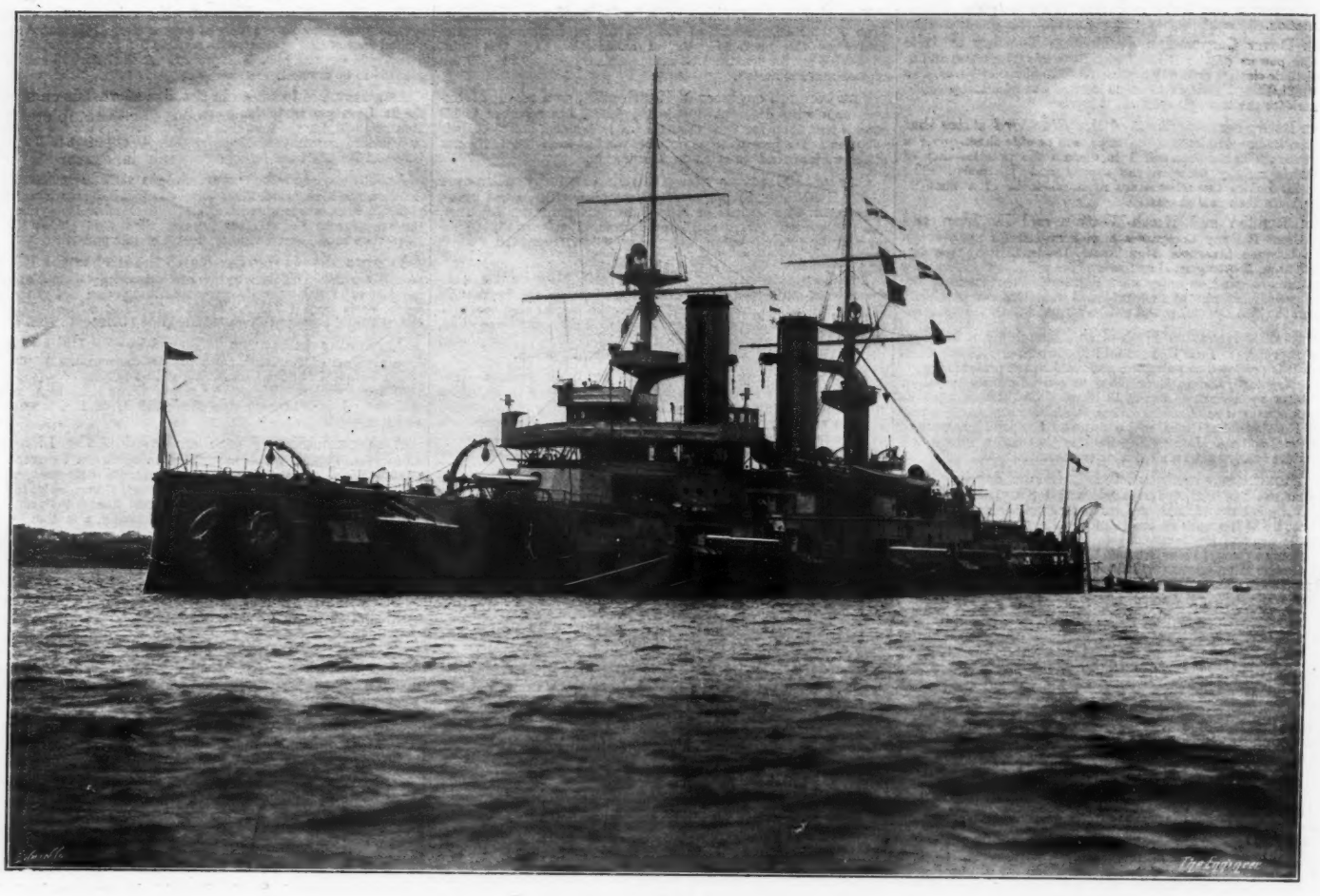
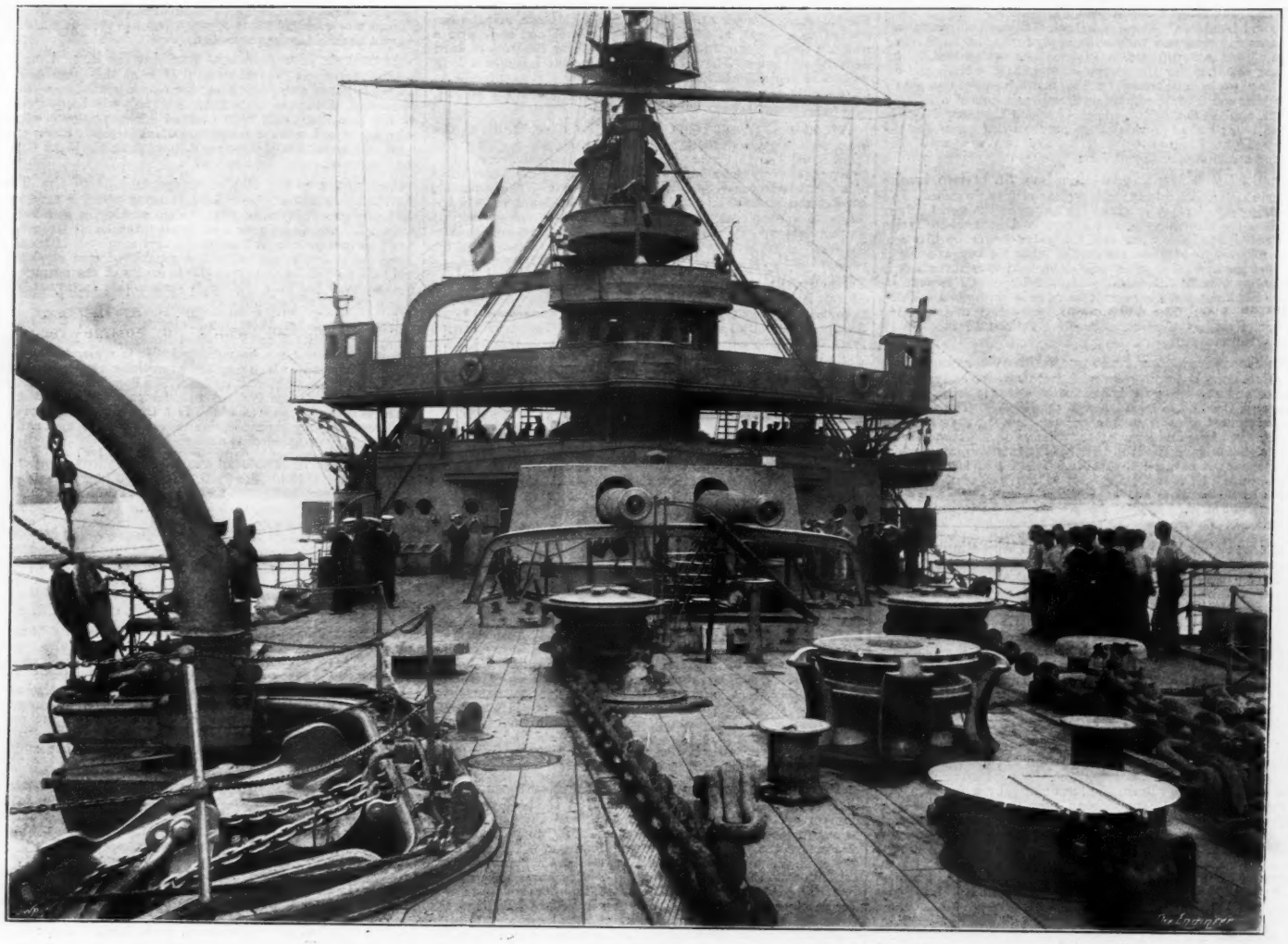
(*For description see page 520*)





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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

X. Y. B.—(1) We should advise you to write to the Birkbeck Institute, Bream's-buildings W C. (2) You might try "Pioneer Irrigation and Light Railways," by E. O. Mawson and E. R. Calthrop, published by Crosby Lockwood and Son.

J. R. T.—You might try "The Steam Turbine," by Robert M. Neilson, second edition (Longmans, Green and Co.), price 10s. 6d; and "Dampfturbinen Entwicklung Systeme Rau und Verwendung," by Wilhelm Gentsch published by Williams and Norgate, price 16s. We should strongly advise you in addition to look up the various papers which have been read before the English institutions.

A. F. F.—You might try "Steam and the Steam Engine," by Prof Ewing (Messrs. Clay and Sons, London); "The Thermodynamics of the Heat Engine," by Sydney A. Reeve, 10s 6d. (Macmillan and Co, London); "Entropy or Thermodynamics from an Engineer's Standpoint," by James Swinburne, 4s. 6d. (Archibald Constable and Co., London); "Differential Calculus for Beginners," 4s 6d; "Integral Calculus for Beginners," 4s. 6d., both by Joseph Edwards, and "Differential and Integral Calculus," by Prof A. G Greenhill, 10s. 6d.; all these last three being publishe by Macmillan and Co.

W. G. (Southampton).—The ordinary methods of hardening copper are rolling, beating, cooling slowly, and alloying. The following books relating to copper you may find useful:—"Modern Copper Smelting" by Edward Dyer Peters (Scientific Publishing Company, New York); "The Hydro-metallurgy of Copper," by M. Eisler (Crosby Lockwood and Son, London); "Modern Electrolytic Copper Refining," by Titus Ulke (Chapman and Hall, Limited, London) In the appendix to the latter will be found a chronological list of books, patents, and special articles on electrical and electrolytic copper refining, methods and apparatus.

INQUIRIES.

PERKINS METAL.

Sir,—I shall be obliged by the address of a maker of Perkins metal.
November 2 st. P. G.

TATTERSALL'S EMERY GRINDER.

Sir,—I should be obliged if any of your readers could tell me the name and address of the makers of Tattersall's emery grinder.
November 23rd. D. F.

STEAM DRYERS.

Sir,—I would be obliged if any of your readers could inform me where I can obtain records of tests of steam separators or dryers, showing the methods adopted for ascertaining the amount of water removed.
November 21st. Tubes.

MEETINGS NEXT WEEK.

Institute of Marine Engineers.—Monday, November 28th, at 8 p.m., at 58, Romford-road, Stratford, E. Paper and discussion on "Technical Education."

Rugby Engineering Society.—Thursday, December 1st, at 8 p.m., at the Benn Building, High-street. Paper, "Some Notes on High-speed Electric Railway Work," by F. W. Carter.

The Manchester Association of Engineers.—Saturday, November 26th, at the Grand Hotel, Manchester, at 7 p.m. Paper, "Adjustment and Alloys of Engine Shaft Bearings," by Mr. William Turner.

Geologists' Association, London.—Friday, December 2nd, at 8 p.m., at University College, Gower-street, W.C. Paper, "On the Superficial Deposits of Central and Parts of Southern England," by A. E. Salter, D.Sc., F.G.S.

Bradford Engineering Society.—Wednesday, November 30th, at 7.30 p.m., at the Bradford Municipal Technical College, Great Horton-road. Paper, "Advantages of Electrical Driving in Works and Factories," by G. H. Bowden.

Society of Arts.—Monday, November 28th, at 8 p.m. Cantor lectures: I. "Musical Wind Instruments," by David James Blaikley. Wednesday, November 30th, at 8 p.m. Ordinary meeting. Paper, "The British Canals Problems," by Arthur Lee, J.P.

The Institution of Civil Engineers.—Tuesday, November 29th, at 8 p.m. Ordinary meeting. Discussion on "Distribution of Electrical Energy," by John Francis Cleverton Snell, M. Inst. C.E. Friday, December 2nd, at 8 p.m. Students' meeting. Paper, "Midland Railway West Riding Lines: The Construction of Contract No. 1," by R. T. McCallum, M. Inst. C E.

THE ENGINEER.

NOVEMBER 25, 1904.

IMPACT TESTS.

The paper by Mr. Seaton and Mr. Jude read on Friday night before the Institution of Mechanical Engineers is interesting in its subject and excellent in arrangement and illustration. It raises more questions for discussion than it even attempts to settle. Impact tests have been carried out for nearly if not quite half a century—a fact which the modern members of the profession seem to have never learned. But Mr. Seaton and Mr. Jude have dealt with impact tests in a somewhat original way, and it is certain that no other persons have hitherto made so much use of the microscope in investigating the results obtained from this species of test.

As we read the paper and the unfinished discussion which followed it, we feel that the more we learn about steel the less intelligible does its conduct become, and the further off we seem to be from the formation of a consistent theory explaining its performances. When we have a man like Professor Arnold admitting that he does not know why steel breaks in a certain way we feel that our own ignorance must be condoned. But the final and impressive conclusion at which we arrive is that so long as we adhere to the existing molecular hypothesis of the structure of steel we shall make no progress. Physicists, and experimenters, and engineers, can go on ringing the changes on pearlite, and sorbite, and ferrite, and all the rest of the family, without reaching any conclusion which explains in a useful way what it is that makes a steel strong or weak; yet that is the knowledge which is so earnestly sought for. From the story of the facts ascertained by Mr. Jude and Mr. Seaton has been deduced but one positive statement of practical utility, the accuracy of which is admitted by many and still disputed by a few, namely, that tempering in oil greatly augments the power of a steel to withstand shock. That was well known before; and Mr. Jude was only able to add another piece of testimony to a case already fairly complete.

Before any solid result can be obtained from an extended series of tests made in the laboratory or the workshop, it is, we think, essential that some accurate notion should be formed of the nature of the stress which makes the test bar break. It seems to be clear that it is not a tensile stress in the ordinary sense of the term. It is quite true, as Professor Arnold pointed out, that the bar always gives way at the side which is in tension. But this only proves that the stress put on it is called tensile. It has yet to be shown that under shock a test bar will break by compression; but it is quite conceivable that it might. We cannot help feeling that the molecules of the metal are shaken apart just as the sand can be skaken down in an hour glass, if it stops running. Disintegration from shock takes place in all sorts of materials. Indeed, impact has been used from prehistoric times to break things up. The stone axe was used with equal effect on the head of an enemy, or to obtain access to the insides of shells. Up to a recent period mechanical engineers have rested quite content with the results obtained with the normal testing machine. The makers of rails and axles and tires have used much more practical methods of ascertaining the quality of iron and steel. It seems remarkable, indeed, that those who daily use steel under conditions of shock should have failed to apply shock or impact tests to it, the value of which has been so long known. Even now, however, no one appears to have recognised the importance of making the tests under working conditions, although Lloyd's proving house has provided an example of considerable antiquity. The impact test ought to be applied to an object already under stress. When chains or cables are being tested the links are struck with a heavy hammer, the importance of submitting the links to shocks while under stress being fully recognised. Mr. Seaton and Mr. Jude cited the fracture of piston-rods within the body of the piston as examples of failure brought about by shock stress; but neither they nor anyone else took notice of the circumstance that the portion of the rod inside the piston was already sharply stressed by the pull of the nut screwed hard down on the piston.

Another direction in which the effect of shock claims careful study is the gradual elongation which takes place when a bolt or a bar is submitted at the same time to shock and tensile stress. Patents for lock-nuts are taken out in multitudes, very generally with the idea that a good lock-nut would keep fish-plates tight. The theory is wholly erroneous. Fish-bolts become slack not because the nuts turn round on them, but because the bolts go on stretching, and the stretching is the result of the vibration set up by the passing trains. The fact tends to enlarge very much our notions of what a metal is. Tresca showed a great many years ago that iron and steel are only solids in name. His researches on the flow of solids are classical, and they have a peculiar bearing on the very curious statement made by Professor Arnold on Friday night, to the effect that the time element is of the utmost importance in carrying out impact tests. It is essential that the time interval, whatever it may be, between the blows should be a constant. If it is not, the results obtained are irregular, and upset all preconceived views. Why this should be so it is impossible to say. A test bar regularly bent backwards and forwards, once in a second, will withstand a number of impacts which seem to bear no relation at all to that which the specimen will stand if the impacts are made three or four in one second, and then none at all for several seconds, and so on. Again, the rate at which the stresses recur seems to be of great importance. Now, Tresca has shown that a nut 3in. thick can be pierced cold by a steel pin one-fourth of an inch in diameter, provided some hours are allowed for the operation. It has often been said that a bridge has not given way under the rush of a heavy train because "it had not time to break." The proposition has been taken as a jest, yet Professor Arnold almost seems to imply that there is an element of truth in it.

It remains yet to be considered what effect the pursuit of this inquiry may have on the manufacture of steel. The unfortunate deduction is that

while a good impact steel is certain to stand the ordinary tensile tests very well indeed, there is no certainty that the proposition is reversible. Steels which give admirable tensile and contraction and bending tests may be among the worst for dealing with impact stresses. The authors, it will be seen, no doubt for good reasons, have not mentioned any particular "make" or brand of steel as complying or not with the required conditions. So far their deductions are incomplete. Again, it will be seen that they hold that impact tests should be made on notched or nicked bars, and this brings us back to a statement which we have already made in a previous impression, to the effect that the phenomena of fracture by initial cracks deserve the most careful investigation. A familiar instance may help to a comprehension of our meaning. The split made by a diamond in glass is excessively shallow; it is not a scratch, but a distinct crack. If, when the glass is thick, it will not part readily in the fingers, the man "cutting" it taps it lightly at one end with a key or the steel body of the cutting tool. The shock will instantly serve to make the crack extend through the thickness of the glass, which parts at once. Now, nicking has the same effect on steel as a diamond has on glass, or it has not. We fancy that it has not. It remains to be seen what effect it really has. Possibly it puts a small portion of the bar close to the bottom of the nick in high tension. It does not seem that the effect of nicking can be explained in any way as the result of diminution of section. This and various other questions may be discussed with great advantage, perhaps, at the next meeting of the Institution of Mechanical Engineers.

THE FRENCH MARINE.

THE investigation of the Extra Parliamentary Commission into the condition of the French marine has had the first result of giving a distinctly reforming character to the report of the *rapporteur* on the Naval Estimates. As is well known, the *rapporteur* is a member of the Chamber who acts as a sort of advocate for the ratepayers, and, while approving or criticising the various credits, he is able to pass in review the whole naval administration, the criticism sometimes being carried to the extent of proposing wholesale reforms that are perhaps more ingenious than practical. The office of *rapporteur* is often the first step to the higher dignity of Minister of the Marine, although experience has shown that the best *rapporteurs* do not always make the best Ministers. In the present case the work of preparing the report has devolved upon M. Charles Bos, who has given a decidedly novel turn to the ratepayers' view of the naval administration. In view of the almost entire suspension of naval construction, M. Bos has naturally made a special point of the retrograde tendency of the French marine. On all previous occasions it has been the custom to insist on this backwardness by a comparison with what was being done by the British Admiralty; but for the first time we see Great Britain left out of the reckoning as being "too manifestly superior," and the drawbacks of the French marine are brought into strong light by a comparison with the German navy. Had the 1900 programme terminated within the specified time of six years, the marine would have been assured of maintaining its position as the second naval Power of the world; but with the changes and reforms and the constant tampering with the programme France is likely to find Germany on the same level as herself in 1908, while if things continue as they are at present, every year afterwards will see Germany steadily increasing her lead on France.

All this is due to Germany having adopted a programme which she is following up without allowing it to be modified at the caprice of successive Ministers. If France is to maintain her position she must at once see about building new ships without waiting for the termination of the 1900 programme. M. Bos, therefore, proposes a programme of his own, which he divides into two parts, the one providing for the constitution of a homogeneous flotilla of destroyers, submersibles, and submarines, and the other for the construction of fifteen big vessels. It is evident that little can be done for the first part of this programme until the Superior Marine Commission has decided upon the final types of submarines and submersibles to be adopted. This question has been thoroughly dealt with during the inquiry, when the Extra Parliamentary Commission took the evidence of all the engineers who are identified with submarine and submersible boats, and, on the whole, it appears as if the opinion which has prevailed until recently in favour of the submersible has veered round again to the submarine. A proposal to create a new type that would possess the advantages of both, without their defects, has been rejected, on the ground that a compromise would only result in an unseaworthy and very unsatisfactory craft. There is, therefore, much to be done before M. Bos can see the creation of his homogeneous submersible and submarine fleet. He also advocates the building of a new type of battleship, or, rather, a compromise between the battleship and the cruiser. Speed would be increased at the expense of armour, without sacrifice of armament. Nine big "cruiser-battleships" and five smaller ones are proposed. It is very doubtful, however, whether this part of the programme will receive much support during the coming debate, for the French have always advocated efficient armour, and a battleship that is unable to withstand as many hard knocks as it can give is not regarded with favour among naval engineers.

As the question of a new programme has been raised in the report it may, at all events, result in interesting developments in the forthcoming debate. It is, however, one thing to sanction a new programme, and quite another to carry it out. The voting of credits will not present any difficulty. The first serious obstacle is the want of men. The law reducing compulsory service to two years will result in a diminution of hands, and the only remedy, according to M. Bos, is to offer advantages to the maritime population to engage for five years, and inducements to those who have served their time to re-engage for a further period. All this, of course, means an increase in the naval expenditure. Then comes the question of building the ships. We have already dealt with that part of the Extra Parliamentary Commission inquiry relating to the cost of shipbuilding in France, from which it appears that there has been a heavy diminution of production coinciding with an augmentation of expenditure. M. Bos goes fully into this matter. He points out the unsatisfactory results that have followed upon an increase of wages and the adoption of the eight hours' day in the arsenals, and asserts that this is partly the cause of the delay in carrying out the shipbuilding programme. M. Pelletan himself has made a public declaration on this point, in which he admits that the attempts to give a socialist character to the arsenals by authorising the men to form themselves into syndicates, and by reducing the hours of labour to eight and increasing the pay, have not given the results expected. The banding of the men into socialist organisations has given them a sense of their power and authority, which is seen in the way in which they are holding out for further privileges, threatening to strike on the slightest provocation, and publicly insulting the admirals and other officers who are placed in authority over them. In some of the ports the men are insisting on the eight hours' day being counted from the moment they leave their homes to the time they return.

A state of anarchy is reigning throughout the arsenals, where there is now an entire absence of authority, and there is no saying from one day to another whether the men will not cease work for some fancied slight or for an extension of privilege. A partial strike has already broken out at Lorient. At Brest 800 men have declared in favour of a general strike. The Minister of Marine is so disappointed over the failure of his experiment that he has announced that he will make no other concessions which may have the result of jeopardising the national defence, and a serious struggle is obviously impending. Having raised up the socialist difficulty, it will evidently need a considerable effort to return to the former state of things, especially in view of the strong socialist element in the Chamber of Deputies, and it is evident that a good many of the Minister's reforms will have to be undone before the Chamber can even begin to discuss the proposals for a new shipbuilding programme.

H.M.S. TERRIBLE.

SOME nine years ago the great cruiser Terrible came as an innovation and a surprise. She was the embodiment of novel theories, and the representative of the latest practice in naval architecture and marine engineering. She began well, but her youth of promise was not followed by a respectable middle age. Her Belleville boilers went wrong, and her machinery was not economical. We need not follow her career; more recent additions to the Navy have drawn attention away from her. Within the last fortnight attention has, however, been again directed to her, and certain optimistic reports of her latest performances have appeared in the *Times* and other papers. They have been published without question, and used to resuscitate the somewhat moribund reputation of the Belleville boiler. The reports are, however, too remarkable to be passed over in silence. We venture, indeed, to think that our readers will find matter in them of an intensely original and surprising character. In dealing with these reports we wish it to be understood that we do not intend to say anything about the part which the Belleville boiler is made to play in them. The question of boilers does not, indeed, arise at all; nor is it necessary to go into minute detail, or do more than consider the broad statements set before us.

In 1902 the Terrible went to China and came back. Her mean speed on the double voyage was 11·8 knots, obtained with an average of 5738 indicated horse-power. Her mean draught was 26ft. 7in., and she steamed 1·22 knots for each ton of coal consumed. In 1904 she made a similar trip to China and back. Her average speed for the double voyage was 12·6 knots; her draught going out 28ft., and coming home 26ft. 5¾in.; her average power 4692 horses; and she steamed 2·34 knots per ton of coal burned. Here, then, we have an increased speed of 0·8 knots, with 1044 indicated horse-power less, although the displacement of the ship was considerably augmented. Let us for the moment disregard this augmented displacement, and, for the sake of argument, assume that the power required varied only as the square of the speed. On this basis we find that if 11·8 knots required 5738 indicated horse-power, then 12·6 knots would have required 6530 indicated horse-power. It is quite certain, however, that the resistance augments much more rapidly than the square of the speed, and we shall not overstate the case when we say that 7000 indicated horse-power ought to have been the least that would give the extra 0·8 knot. We are told, however, that the average power was actually 4692 horses, or 2300 indicated horse-power less than calculation asserts it ought to have been. If, on the other hand, a speed of 12·6 knots could be had for 4692 indicated horse-power, then 11·8 knots ought to have been attained with no more than about 4000 indicated horse-power. Thus, on whatever basis we calculate, we arrive at results which are, so far, incomprehensible.

There are four ways in which these astounding figures can be explained. First, the propellers used this year may be better than those of two years ago; secondly, the weather may have been more propitious; thirdly, the vessel may have been better trimmed; fourthly, the indicated horse-power on the first or 1902 trial may have been over-estimated. Now, we may say at once concerning these supposititious explanations that the Terrible's propellers have not been changed. The voyages lasted so long that differences of weather of any serious import were not likely to have existed. The extra displacement of nearly a foot must have counteracted any possible influence of trim; and it may be added that there is not much opportunity for altering trim in a warship. This disposes of three out of four of the conceivable explanations of the results said to have been obtained. There remains, then, the hypothesis that the engine-room log of the 1902 China trip is untrustworthy. But if we once begin to doubt, where shall we stop? May not the log of the 1904 run be just as much lacking in accuracy as that of 1902?

If, however, we assume that the power required to propel the ship was really in accord with the knot rate on the first voyage, as well as the second, and so get rid of incompatibilities, how are we to explain the circumstance that the consumption of fuel in 1902 was about twice as great as in 1904 for the same voyages? It has been a favourite plan with the believers in the Belleville boiler to explain all its shortcomings as the result of the incompetence of Naval engineers. It was said that they had not learned how to use the new system of generating steam to the best advantage. But whatever force that argument may have had in the early days, surely it cannot apply to a time so recent as 1902. If this reasoning is introduced to account for the improved economy of the machinery which enabled the ship in 1904 to steam 2·34 knots per ton as against 1·22 knots per ton in 1903, we are at once overwhelmed with curiosity. We want to know what changes were made in the management of the ship, her boilers, her engines, and her auxiliaries, to bring about a result so admirable. Are we to assume, for instance, that better lubrication saved a loss of about 2300 indicated horse-power in friction? We have heard that everything hot was lagged on the last voyage as it had never been lagged before; but to claim much for this is to censure past practice. Indeed, the difficulty in dealing with this subject is to know who ought to be blamed and who ought to be praised. Let the competence or incompetence of the engine-room staffs be what it may, however, we have still the performance of the ship herself to explain. With that those on board had nothing to do. They could not help the ship to make nearly a knot more with 1000 indicated horse-power less, and so, in the last resort, it must be accepted that the newspaper reports with which we

have dealt are probably inaccurate, certainly unofficial, and at best, leaving very much unsaid, and everything unexplained. If there is really a foundation of fact, then let us trust that the Admiralty may be in a position to make use of it. It will be long before a more valuable lesson can be learned than how to make a great cruiser go nearly twice as far at a higher speed than she has ever done before on 1000 tons of coal.

In writing as we have done, it may be said that we are censuring or praising men who cannot speak for themselves, whose mouths are officially sealed. But it must not be forgotten that there are numbers of retired marine engineers who are practically free to speak or write as they please, and so defend or blame where defence or blame is expedient. For ourselves, we do not pretend to award either praise or blame. The figures which we have reproduced obviously emanated from the ship. It is not to be supposed for a moment that they are pure inventions foisted on our contemporaries. It is, however, none the less certain that as they stand they are entirely incompatible with all received theories of the propulsion of steam vessels. The more carefully and minutely the figures are worked out the more incongruous, even grotesque, do they appear. The questions at issue are, however, of great scientific importance. They will probably figure in the forthcoming debate next year on the Naval Estimates; and not the least interesting feature of the whole matter is the ostensibly remarkable revelation that is made of the influence of the man in a ship apart from the machinery.

WORKMEN'S TRAINS.

A SELECT Committee of the House of Commons was appointed last session to inquire into the working of the Cheap Trains Act. A serious attempt is being made to compel the railway companies to give more facilities for the carriage of working men at each end of the day at absurdly low fares. It is quietly assumed that the railway companies could do much more than they do if they chose. Much evidence has been taken for and against the companies. But in the whole discussion the personal element is overlooked in a very curious way. It is no use providing trains if they are not used. We can give an interesting illustration of this. On the Great Eastern Railway a workman's train was provided which could seat 800. The accommodation was increased, and the train constantly took 1100 passengers out of Liverpool-street. The demand increased; the train was divided, the second half starting two minutes after the first. Then a third train was added, the total accommodation provided being about 3600, the third train starting four minutes after the first, all three from the same platform. Nothing like this number of passengers is ready at one time, and as the trains will each seat about 900 persons there is plenty of room. But the British working man refuses to avail himself of these facilities. The first train often goes out with 300 persons in it, while the second is packed to suffocation. At other times the third train is the one selected. It must be understood that the people are all there on the platform. It seems to be enough for a guard or a porter to tell them to get in. A free-born Briton will not go till he pleases. But he will complain afterwards of overcrowding. Many other idiosyncrasies of the cheap railway traveller might be mentioned which vex the souls of traffic managers. Instead of permitting mobs to collect on island platforms, it is possible that better results would be got by adopting the continental system of regulating access by gates. There is nothing special, we may say, about a Great Eastern Railway crowd. The personal difficulty makes itself equally felt all over the kingdom.

THE BATTLESHIP DEUTSCHLAND.

On November 19th, at Krupp's Germania Yard, Kiel, the first ship of the new class, known until now as the "N" class, was launched, and received the name of Deutschland, by the Emperor, who performed the christening ceremony. The evolution of German naval construction which has led to the type of battleship just launched may be said to have started from the ships of the Kaiser class; these were followed by those of the Wittelsbach class, a much improved edition of which is the series of battleships, Braunschweig (1902), Elsass (1903), Lothringen (1904), Preussen, and Hessen. The warships launched in the last financial year are:—

Battleships.	Armoured cruisers.	Protected cruisers.
Preussen	Roon	Hamburg
Hessen	York	Bremen
Elsass	—	Berlin

The Deutschland initiates a new series of improved Braunschweigs, though the improvements may be said to concern more details than the basis on which the German Admiralty has founded the solution of the battleship problem.

One improvement is the increase of the battery armour, which in the Braunschweig is 6in., and in the new ships will be 6⅞in. In the Braunschweig class the four 17 cm. (6·7in.) Q.F. guns, above the battery, are mounted in turrets, whilst in the new class this installation has been repudiated, and single casemates have been adopted instead of turrets. This is a remarkable instance of the difference of opinions entertained on the subject of turrets *versus* single casemates by English and German authorities, and it may be of interest here to examine the *pros* and *cons* of both systems. The reasons which have led the German Admiralty to adopt single casemates for intermediate-calibre guns are enumerated by "Nauticus,"* and may be reduced to the following:—Diminution in weight, greater simplicity in the transmission of orders, and economy; the advantage is also emphasised which is obtained by being able to place the 8·8 cm. (3·5in.) Q.F. on the top of the casemates, so that these guns are well supported and their ammunition hoists protected. As for the drawbacks of single casemates, the principle is the great reduction of the angles of training, if an efficient protection is to be obtained. In regard to the mounting of intermediate-calibre guns, what has taken place in the British Navy is just the contrary of the latest German practice. The system of single casemates is the one which has been exclusively adopted in England up to the ships of the King Edward class. This class and the Lord Nelson class mark a decided improvement on the Queen, London, and Formidable classes, especially on account of the installation of the secondary armament. The British Navy may be said to have the best experience as far as single casemates are concerned; in fact, up to the two last classes of ships built and building, the proportion of guns of intermediate calibre mounted in single casemates, turrets, and box batteries, expressed in percentage of the total number of such guns, is:

In the British Navy	92	4	4
In the German Navy	32	31	37

Now, just when commencing a new series of warships, England is condemning single casemates—in which more than 850 British naval guns are mounted—and adopting turrets, whilst Germany substitutes turrets with single casemates in the new Deutschland class.

The progress in torpedoes and torpedo craft has required an improvement in what the Germans call "Antitorpedo-bootsartillerie," and this is, no doubt, to account for the increase of 8·8 cm. guns in the Deutschland class. *Apropos* of the armament best fitted to fight destroyers, the late experience seems to prove the inefficiency of 37 mm. machine guns, and points out to naval designers radical modifications in the choice and distribution of small guns in the battleships of the future.

If that expression, which has had such great success among amateurs of naval problems, that "the microbe will kill the giant" has some particle of sense in it, this is only owing to the fact that the progress of anti-torpedo artillery has not kept ahead of the progress of torpedo armament. Those of the new school who have proclaimed the "*banqueroute des grands cuirassés*," as they picturesquely call it, have still to reckon with a current of new ideas which will probably revolutionise the whole system of anti-torpedo boat guns, their calibre, and their installation. No calibre under 3in. will prove efficient, and instead of scattering machine guns on military tops, or wherever there is room left for them, where they are sure to be swept off by the first shells exploding on the enormous superstructures of the present battleships, a more rational plan must be studied, by means of which it must be possible to concentrate in a few positions the required number of guns which are to do their work throughout the whole naval action in which the ship will be engaged. These guns must have the command of the sea in all directions, within a range of at least 2000 yards, so that any torpedo craft sighted between 3000 and 2000 yards may be annihilated before it gets within a dangerous distance. An inclination to standardise the calibres of the heavy guns and abolish intermediate calibres may be noticed in the ideas lately expressed by different naval critics; if this will mark the new direction of progress in naval design, the new types of battleships will be with great probability based on a heavy gun standard calibre and a standard anti-torpedo boat calibre, presumably 12in. guns and 8·8 cm. to 10·5 cm. (3·5in. to 4⅛in.) guns respectively.

To return to the Deutschland and point out some of her features, which will confer to the whole class of her name a number of valuable qualities, and make it an *ensemble* of powerful, uniform, and well-protected fighting units. The Deutschland embodies a thoroughly well studied compromise of all the requirements a German battleship must answer to. As it may be instructive to compare the principal data of the Deutschland with those of other types of warships lately built and building, their characteristics have been gathered in the accompanying table. The most remarkable feature of German naval design is the so-called "intermediate displacement," which also in the new class is not surpassed. No doubt there are good reasons to account for conservatism in this practice—reasons of a general kind, applying to the navies of all countries, and others imposed by special conditions which the German navy must satisfy. The advocates of the 13,000-ton displacement say, first of all, that experience shows that it is not prudent to lay too "high a stake on one card;" besides, Germany must reckon with shallow waters, canals, and limited possibilities of docking.

Considering the displacement, the Deutschland is a capital warship, which reflects much credit on German naval constructors, as she is the happy result of an organic and rational conception of what a fighting ship should be. It might be observed that, since battleships are made to fight battleships, their absolute value is of much smaller importance than their relative value as compared to other battleships, and, once the type is established to which a fighting unit must belong, this must stand fair chances of success whenever engaged in a combat with whatever other unit of the type chosen. It is not always practically possible to apply this theory, but whenever one of the fighting qualities of a warship is in a condition of inferiority, some other prominent feature should be so developed as to make up for the one defective, just in the same way as Nature in some living beings develops the sensibility of some organs when that of some others is missing or imperfect. To come to a concrete case, if a limited displacement is a condition *sine qud non* for a given battleship, her speed must be such that in ordinary circumstances she must be at liberty to accept or refuse a battle, and impose the combat and its conditions upon the adversary. Limited displacements and great speeds are only compatible with the sacrifice of protection, armament, or tactical qualities, but in the whole the sacrifice of one of these may lead to a fighting unit of more military value than that in which offensive and defensive qualities are equally distributed.

For the sake of argument we may consider the instance of a modified Deutschland, say with 20 knots speed; she would always be able to get out of the way of a République, which, owing to her inferiority in speed, would not get a chance to utilise her formidable armament; such a Deutschland could on the other side inflict severe damage on a Triumph* with her heavy 28 cm. guns.

A Deutschland, as she actually is, with 18 knots speed, cannot escape a République nor prevent her 9in. belt armour being pierced by the République's 12in. guns, and cannot inflict any serious damage upon this hypothetical enemy whose armour makes her the most invulnerable ship afloat; the 18-knot-speed Deutschland would not have a chance to engage in a battle with the Triumph, which, conscious of the Deutschland's superiority, offensive and defensive, would have to rely for her safety completely on the evolutionary superiority her 19 knots speed confers on her.

Examining further the fighting qualities of the Deutschland, it may be said that the choice of the 17 cm. guns, as an intermediate calibre, has more enthusiasts than opponents. The latter affirm that all guns above 6in. cease to be easily handled, and that the rate of fire is much reduced if they are not loaded automatically, and therefore the doubtful advantage of a better protection and of economy in weight is not enough to justify their mounting in casemates.

Regarded as gun target, it may be said of the Deutschland that in this respect she will mark no improvement on her predecessors. But the proportions superstructures have assumed in modern war vessels is no speciality of German ships alone. The amount of deck-houses, bridges, platforms, guns, and other encumbrances crowded in the neighbourhood of the conning tower form a characteristic feature in most other navies' ships, and it is inexplicable how this condemnable practice has so many adherents. ARGONAUTA.

Principal characteristics.	Deutschland class.	King Edward class.	République.	Imperator class.	Kansas class.	Kashima class.	Vittorio Emanuele class.
Nationality	German	British	French	Russian	U.S. of A.	Japanese	Italian
Normal displacement, tons	13,000	16,350	14,850	16,630	About 16,000	16,400	12,680
Length at the water-line, ft.	400	425	440	425	450	455	435
Extreme breadth, ft.	72	78	70½	78	76¾	78½	78½
Mean draught, ft.	25¾	26½	27½	27	27½	26¾	25½
Speed	18	18·5	18	18	18	18·5	22 (?)
Indicated horse-power	16,000	18,000 (?)	17,500	18,000	16,500	21,500	21,000
Armour—							
Water-line belt—Amidships, in.	9	9	11	11	9	9	10
" " Forward, in.	7 and 4	6 and 3	6	6	4	6½	6 and 4
" " Aft, in.	7 and 4	2	6	6	4	6½	6 and 4
Citadel side armour, in.	5½	8	10	?	7	6	8
Casemate side armour, in.	6¾	7	6	None	7	6	None
Heavy gun barbettes, in.	10	12	11	12	10	9	10
Turrets, in.	11in. guns, 11	12in. guns, 12 9·2in. guns, 7	12in. guns, 12 6·4in. guns, 5	12in. guns, 12 6in. guns, 7	12in. guns, 10 8in. guns, 6	12in. guns, 9 10in. guns, 5	10in. guns, 10 6in. guns, 6
Armoured deck, in.	3	2	2 + 3	4 + 2½	3	3	4
Conning tower—Fore, in.	12	12	12	12	9	9	10
" " Aft, in.	6	3	—	6	5	4	—
Artillery	4 11in. in two turrets 14 6·7in., 10 in casemates, 4 in single casemates 22 3·5in. (24-pdrs.) 4 3·7 cm. 4 8mm. 1 6cm.	4 12in. in two turrets 4 9·2in. in turrets 10 6in. in casemates 14 3in. 14 3-pdrs. 2 Pom-poms	4 12in. in two turrets 18 6·4in. in turrets and casemates 26 3-pdrs. 2 1-pdrs.	4 12in. in two turrets 12 8in. in turrets 20 3in. 20 3-pdrs.	4 12in. in two turrets 8 8in. in turrets 12 7in. 20 3-pdrs. 12 Machine guns	4 12in. in two turrets 4 10in. in four turrets 12 6in. in casemates 12 12-pdrs. 6 Pom-poms	2 12in. in two turrets 12 8in. in six turrets 12 3in. 12 3-pdrs. 4 Maxims
Torpedo tubes—							
Bow	1 18in.	—	5 (2 / 3)	1 / 2 / 1	4	4 / 1	4
Broadside	4 18in.	4 18in.					
Stern	1 18in.	1 18in.					
Coal, normal, tons	800	950	900	?	2000 (?)	1200	1000
" bunker capacity, tons	1800 + 200 oil	2000	1850	?	2200	2000	2800

* "Jahrbuch für Deutschlands Seeinteressen," Berlin, 1904.

LAUNCHES AND TRIAL TRIPS.

ST. GILES, stern-well hopper dredger; built by, Messrs. Wm. Simons and Co., Limited; to the order of, the British Admiralty; the trials were satisfactory.

DELTA, steel screw steamer; built by, Wm. Gray and Co., Limited, West Hartlepool; to the order of, Mr. B. J. Van Hengel; dimensions, 292ft., 42ft. 6in by 19ft.; engines, triple-expansion, 21in., 33in., 56in. by 36in., pressure 160 lb.; constructed at the Central Marine Engine Works; a speed of 10½ knots was averaged; trial trip, November 15th.

SYLVIE, steel screw cargo steamer; built by, Sir Raylton Dixon and Co., Limited; to the order of, the Société les Affreteurs Reinus of Paris; dimensions, 310ft., 43ft. by 25ft. 9in.; to carry, 4300 tons dead weight; engines, triple-expansion, 23in., 38in., 61in. by 42in., pressure 160 lb.; constructed by, North-Eastern Marine Engineering Company; trial trip, November 15th.

MONTCALM, twin screw ice breaking steamer; built by, Messrs. Fleming and Ferguson, Limited; to the order of, the Canadian Government; dimensions, 1300 tons gross register; engines, triple-expansion, 23½in., 38in., 64in. by 42in.; the engines indicated 3900 horse-power, and a speed of 14½ knots was attained; trial trip, November 15th.

DEPARTMENTAL COMMITTEE ON DUTY-FREE ALCOHOL.—The Automobile Mutual Protection Association have instructed Mr. Shrapnell Smith, F.C.S., M.R. San. Inst., M. Soc. Chem. Ind., to represent them before the Committee appointed by the Chancellor of the Exchequer to inquire into the use of duty-free alcohol for industrial purposes. Mr. Shrapnell Smith strongly advocated the use of alcohol in an address to the Lincolnshire Automobile Club over two years ago, and his training as a chemical engineer should stand him in good stead on this occasion.

* Triumph and Swiftsure, 11,800 tons displacement and 19 knots, belt and side armour 7in.

RAILWAY CARRIAGE VENTILATION.

One of the most important questions that arise in the design of a railway carriage is that of efficient heating and ventilation. Although the matter has received considerable attention of late years, it cannot be said that in every case the present systems are altogether perfect. Dr. Chas. B. Dudley has recently issued a pamphlet describing the passenger car ventilation system used on the Pennsylvania Railroad Company. This company has adopted the combined heating and ventilating system, and it is interesting to note the results of the experiments which have been carried out. In one of the trials as many as twenty Globe ventilators were used in one car, and it was found that the ventilators on the front of the car acted so vigorously in producing a vacuum that the ventilator at the rear part of the car took in air instead of exhausting it. Another peculiarity connected with this test was that the back part of the car was found to be colder than

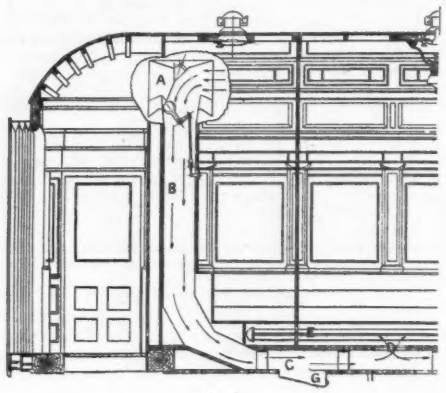


Fig. 1

the front end, and it was the attempt to find out why this was so that led to the discovery of the vacuum produced instead of the delivery of air into the car. Dr. Dudley, in his report, states that: "We are very firmly convinced that exhaustion of air from any space is not ventilation. There must be fresh air supplied as well as the removal of all polluted air from the place that it is sought to ventilate." The accompanying illustration—Fig. 1—shows the method now adopted, and gives a view of the system employed. The left-hand end of the car is shown in section through the hood A; B is the downtake; C the air passage; D the floor apertures; and E the heater box. The heater boxes are placed under the seats. The air currents are shown by the arrows. The appendage G allows the air passage C to be cleaned, which is necessary owing to the small cinders, dust, &c., that accumulate there. It was thought that, by having holes in the appendage, the air would blow the cinders through, but this theory has been proved to be incorrect. The principle is very simple. It consists in taking in air from the outside through the hoods at diagonally opposite corners of the car, thence through the downtakes underneath the hoods to the spaces, one on each side underneath the floor, bounded by the floor, the false bottom, the outside sill, and nearest intermediate sill. These spaces extend the whole length of the car, and are 14in. × 7½in. From these channels the air passes up special apertures through the floor over the heating systems, and thence out into the car, and finally escapes through the ventilators situated on the centre line of the upper deck. Fig. 3 shows the construction of the hood and downtake. The wire gauze H covers the two faces of each hood, its object being to prevent cinders from entering, especially such as might lead to fires. I is a flap valve, and is so manipulated that the air has a free passage into the

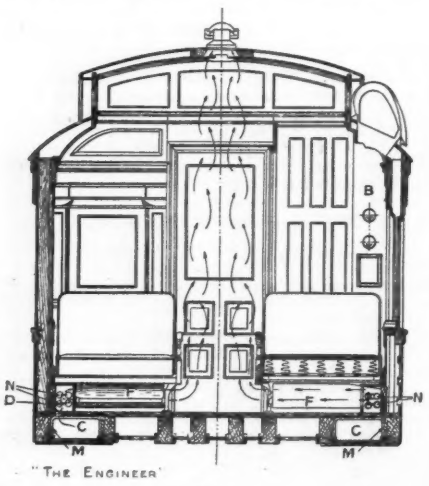


Fig. 2

downtake B from the direction in which the car is moving. This valve is operated from within the car, and there is an indicator J to show which way the valve must be opened, which depends upon the direction in which the car is running. An inspection door K is placed in a convenient position to allow the mechanism to be examined when necessary. L is a butterfly valve, by which it is possible nearly to close the aperture. This is only closed when going through tunnels, in order to exclude foul air, or when standing in stations with the locomotive detached, and it is desired to keep the car warm as long as possible. A cross section of the car is shown in Fig. 2. On the right hand can be seen a section, through the middle of a seat, showing the air passage C, the heater-box M, heating pipes N, and an outside view of the tube F. The left-hand part is a section midway between the seats. The apertures in the floor are 12in. × 2in., and there is one of these slots between each two seats on both sides of the car. The heating is done by means of pipe radiators. These extend nearly the whole length of the car, and are enclosed in a continuous boxing, 5½in. by 8½in., inside dimensions. Steam from the locomotive is used for heating, although with proper arrangement of the amount of heating surface hot water may be used. The steam is supplied to the radiators at the middle of the car, and the condensed water is returned to the middle of the car also, and from there is allowed to flow through proper traps on to the track. The distance between the centres of the galvanised iron tubes F carrying the heated air from the heater boxes to the aisle, under two contiguous seats, is 35½in., and midway between this distance the 12in. slot through the floor is situated. Thus, the cold air coming through the floor into the heater boxes divides, and passes in contact with the heater pipes each way to the tubes under the seats which carry it to the aisle. This amount of contact, with the proper area of heating surface in the car, and with adequate steam pressure, is found to be quite sufficient properly to warm the car, even in the coldest weather. The amount of air taken into the car is controlled by the ventilators, which are of the type known as the "Globe." Five of these are used in each car over the lamps and one at each end, the latter differing a little from the others. The end ventilators consist essentially of a register valve and the necessary appliances by means of which it is connected to the ventilator itself, and attached to the roof. When the valves are open, the aperture in the register is a little more than equal to the area of the 6in. ventilator tube. The mechanism for regulating the aperture is so arranged that when the valve handle stands lengthwise of the car, the valves are fully open; when crosswise, the valves are closed. The ventilators were originally placed between the lamps, but it was soon found that the lamp ventilators were an important element in the problem, and could not be ignored. When six end ventilators of the end type and five lamp ventilators were used more air was taken through the car than could be warmed in severe weather, and, consequently, on the first cars fitted up the lamp ventilators were partially closed, only an inch or two diameter aperture being left for the escape of the lamp gases. But this resulted in smoking the head lining; accordingly, the combined ventilator was devised for use over the lamps. As all the ventilators can be closed or left open, or

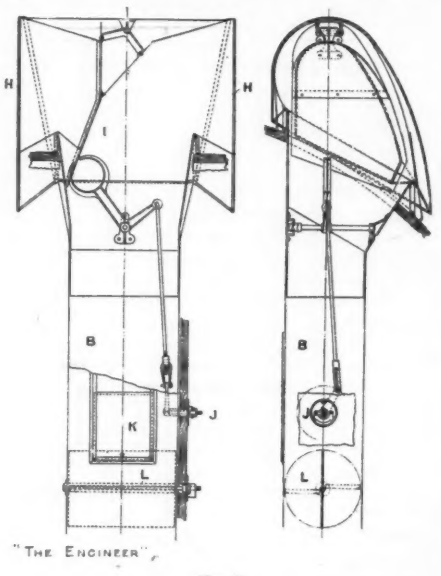


Fig. 3

partially closed, it will be seen that there is great flexibility in the system. This system was tested last December from Altoona to Johnston and back, a distance of about 40 miles each way. Fifty-two workmen were in the carriage, and all the windows were closed during the journey. The outside temperature was 23 deg. to 30 deg. Fah. Rubber bags and bellows were used in obtaining samples of the air. Numerous trial trips were undertaken and modifications made. In making the analysis carbonic acid was the only constituent determined, and from this the amount of fresh air taken through the car per hour by the ventilating system. The following are the data obtained from the trip mentioned:—

	Per cent. of carbonic acid.	Cubic feet of air per car per hour.
Westbound.		
All ventilators closed, Bennington	0·18	20,700
All ventilators open, Buttermilk Falls	0·10	62,400
All ventilators open, standing 20 minutes at Johnstown	0·21	22,000
Eastbound.		
All ventilators closed, Cresson	0·14	37,400
All ventilators open, McGarvey	0·10	62,400
All ventilators open, standing 20 minutes at Altoona	0·20	23,400

In explanation of the figures it may be stated that the stations mentioned denote places at which air samples were taken. Bennington, on the schedule used, is about 23 minutes from Altoona; Buttermilk Falls is about 57 minutes from Bennington, and Johnstown is about 10 minutes from Buttermilk Falls. Returning, Cresson is about 42 minutes from Johnstown, McGarvey about 20 minutes from Cresson, and Altoona about 5 minutes from McGarvey. These figures will give some idea of the interval between samples.

The system was designed to supply 60,000 cubic feet of fresh air per hour to the car, and from the figures it will be seen that the results come slightly above this figure. In order to test the heating capabilities of this system a car was run from Altoona to Harrisburg, a distance of 132 miles, when the outside temperature was 10 to 13 deg. Fah. above zero. The steam pressure maintained was about 20 lb., and from the observations made the following points are said to have been demonstrated:—There was no difficulty whatever in keeping the car at a comfortable temperature in such weather with the ventilating system in normal operation; the distribution of heat throughout the car was satisfactory. A few trains having from three to five ventilated cars have been running now for a little over a year, and the results have given, so we gather, complete satisfaction.

INTER-OCEANIC RAILWAYS.

On the 26th day of May, 1887, the main line of the Canadian Pacific Railway was opened for traffic throughout its whole length of 2906 miles, from Montreal, the St. Lawrence shipping port of the Dominion, to Vancouver, on the Pacific coast, thus completing the first trans-continental railway within British-American territory. The St. Lawrence River being closed by ice for five winter months, access to a Canadian winter port was secured by the construction of 327 miles of railway from Montreal to a connection with the Maine Central Line, so effecting a junction with the New Brunswick Railway having its terminus at St. John. From this point the Canadian Pacific has running powers over the Inter-colonial Railway to Halifax. The harbours of Halifax and St. John are the only ports on the Canadian seaboard that are open to ocean steamships all the year round. A third port, Sydney, towards the north-easterly extremity of Nova Scotia, has the Inter-colonial Railway connection, but the channel approaching that port is liable to occasional blockade in severe winter seasons.

Shortly after the completion of the Canadian Pacific Railway, a second trans-continental railway was commenced. This is the Canadian Northern Railway, of which about 1500 miles, including branches, is completed, with 400 miles in course of construction. The main line extends from Port Arthur, at the head of Lake Superior, through Winnipeg, to the crossing of the South Saskatchewan River, near Saskatoon, a distance of something over 800 miles. From the present terminal another week's work will bring the tracklayers to the North Saskatchewan, on their way to Battleford, and the rails are expected to reach that place before the winter sets in. West of this crossing construction work is in progress at several points along the valley, towards Edmonton, where connection will be made with a short section of railway which has been constructed by a local company holding a charter for a line through the mountains to the Pacific, *vid* the Yellow Head Pass.

For easterly and Atlantic coast connections, the Canadian Northern Railway is mainly dependent, at present, upon the lake and river steamship lines. The bulk of the east-bound wheat traffic is shipped down the lakes to ports on the Georgian Bay of Lake Huron, for transfer to the Grand Trunk and Canada Atlantic Railways. A smaller proportion goes *vid* Lake Erie, the Welland Canal, and the St. Lawrence route, to Montreal and Quebec. In the winter months the Canadian Northern gives its east-bound traffic to the Canadian Pacific, from the head of Lake Superior.

The financial syndicate controlling the Canadian Northern also holds a majority interest in the Great Northern Railway of Canada, which extends from a point on the Ottawa River midway between Ottawa and Montreal, to the city of Quebec, north of and almost paralleling the Canadian Pacific line, which follows the north shore of the St. Lawrence River to the same terminal. East from Quebec, the Canadian Northern controls a charter granted last year for a railway through the maritime provinces to the Atlantic seaboard, with a Government grant in aid of cost of construction. The entire scheme of the Canadian Northern Railway, therefore, comprises a series of existing railways, with plans for construction of intermediate links, designed eventually to constitute a through trans-continental route from the Atlantic to the Pacific.

The Canadian Pacific and the Canadian Northern Railways are, however, open to a political objection which has much weight with the Government of Canada, in the fact that the Canadian Pacific eastern extension to the Atlantic seaboard, to reach its winter port, passes for 200 miles through the State of Maine; while the Canadian Northern main line, midway between Lake Superior and Winnipeg, has 60 miles of its length situate in the State of Minnesota, owing to the great détour necessary to avoid the Lake of the Woods. These railways are, therefore, under divided control, politically as well as commercially, in respect of all through traffic. An order issued by the Washington authorities might at any moment impose restrictions on the movement of trains. This has led to a demand for an entirely new system of railways through the northern country, wholly within Canadian territory, comprising a trans-continental line from ocean to ocean, with branch lines tapping all important centres of trade.

To accomplish this purpose, two schemes have been presented. The plan proposed by the Government provides for the construction of the easterly half of the main line—that is, the section from Winnipeg to the Atlantic, about 1900 miles, by a board of commissioners, the country paying the cost of building the railway. The westerly half, Winnipeg to the Pacific, about 1800 miles, is to be constructed by a company, the Government giving a guarantee of 3 per cent. interest upon three-fourths of the cost for fifty years from date of completion of the line. The company will take a lease of the eastern division, and operate the line throughout, but all Canadian railways may obtain running powers over any sections of the main line on equitable terms.

The alternative proposition, presented by the leaders of the Conservative party, contemplated construction of the entire main line from ocean to ocean as a Government work at the public cost, and the operation of the railway by a non-political commission. On this basis the existing lines of the Government railway system from Halifax and St. John to Quebec, 767 miles, would be utilised as the eastern connection giving access to the Canadian winter ports, so avoiding the duplication of eastern lines contemplated by the first scheme. This plan has now been definitely rejected by the electorate.

The essential point of the Government scheme is that the railway shall be Canadian throughout. All materials and supplies for construction purposes are to be purchased in Canada, if obtainable there in sufficient quantity and of satisfactory quality; the cars and locomotives will be constructed in Canada; the working of the traffic and the tariff of tolls are subject to approval by the Railway Commissioners. The aid granted by the Government is expressly declared to be "for the purpose of encouraging the development of Canadian trade and the transportation of goods through Canadian channels," and "all export traffic, not specifically routed otherwise by the shipper, shall be carried to Canadian ocean ports."

On the western division, surveys have been in progress for the last eighteen months. It is understood that the trade across the prairie country is definitely selected, but the final choice of the route through the mountains to the Pacific coast has not yet been announced. On the mountain section the surveyed lines offer the alternative of a very circuitous route with moderate gradients, against a more direct traverse of passes at higher elevation, involving much steeper grades. Between Winnipeg and the Atlantic terminal, the preliminary

or trial lines are now being run for the purpose of determining the most advantageous route. It is understood that the section north of Lake Nepigon presents engineering difficulties which may necessitate a considerable deviation from the direct line originally contemplated. The crossings of the rivers which have their outlet in the Hudson Bay, will call for large outlay in bridgework, and the intersections of the "height of land," which constitutes the watershed between the great lakes and the northern sea will require very careful examination of all the available routes. The section east of Quebec will traverse a rough and difficult region in the hilly country lying just north of the United States boundary.

From a traffic point of view, the district between Winnipeg and Quebec does not offer much encouragement, the country being for the most part a dense forest, containing a very small percentage of merchantable timber, with a much larger proportion of "pulpwood" bush. The new railway will, however, provide the most direct route obtainable from the wheat lands and grazing region of the north-west country to the Atlantic seaboard of the Dominion, thus opening out a great highway of commerce which will unquestionably serve a political purpose of the utmost importance to the empire.

EXPERIMENTS ON SOME STRUCTURAL DETAILS.

In a pamphlet just issued by Lloyd's Register there are detailed a set of interesting experiments on some structural arrangements and attachments. Ships' draughtsmen have, at various times, proposed to alter the exact methods of assembling indicated by the rules—in some cases to try and effect economies, in others to obtain more space; a few of these proposed deviations from the normal have been tested to destruction under the authority of Lloyd's at Messrs. Palmer's Shipbuilding and Iron Company, Limited, Jarrow-on-Tyne, and the pamphlet is designed to give a detailed account of the experiments which were made to "determine the actual efficiencies of some of the proposals."

There are three different sets of experiments, "girders under beams," "intercostal side stringers," and "the efficiency of the rivet attachment of shell plating to frames." Sample structures of the various proposals were made, and Messrs. Palmers designed a special hydraulic ram for the purpose of bending them.

In the experiments on girders under beams the object was "to determine the value of intercostal plates to such girders as are now usually fitted to support deck beams when pillars are dispensed with." The six samples were made to represent deck plating with the beams and girders under them, three being without and three with the intercostal plates. Fig. 1 shows one of the samples as fitted with the plates, the corresponding one without them being identical in every respect except, of course, that the intercostal plate and its angles were omitted. Three samples of each were tested in order to try the effects of a slight variation of design; in the one case a channel was fitted under the girder in place of the two 4½in. by 3½in. by ½in. L's, and in the other the channel was used, and also the intercostal plate was fastened to the deck plate by double angles, so as to throw the rivets into double shear. It is stated that the samples which were fitted with intercostal plates collapsed at a load more than two and a-half times as great as those carried by samples, which had not had them fitted, whilst the deflections for the same loads were only about one-twelfth. The samples with the channels under proved of the same strength as Fig. 1, except that the one with the double angles mentioned proved that the rivets were better in double than in single shear, as it failed by fracture instead of in the rivets like the others, and carried a load 12 per cent. in excess. Further experiments were then made by fitting 6in. by 6in. lugs or angle brackets to the girders under a deck instead of the intercostal plates, but the latter carried a load nearly three times in excess of the former, the deductions being that the intercostal plates in every instance proved immeasurably stronger than any other design.

Whilst it is doubtless very satisfactory to have these points authoritatively settled by actual experiment in this manner, it appears rather strange that there should ever have been any question as to whether or not the intercostal plates would increase the strength—the real question rather being, how many times stronger would they prove? It is fairly evident that as tested these plates formed the web of a shallow girder, imparting a very certain stiffness to the arrangement, and coping with the shearing stresses developed under the loads. A gain of 250 per cent. in the strength is, however, more than would really be expected, and so far the experiments are of benefit. But they are robbed of their greatest usefulness because there is no information as to how fracture occurred, or its precise position, nor is the condition of the samples shown after fracture. The addition of an angle to the intercostal plates is stated to have increased the breaking load by 12 per cent. It appears that if the rivet pitches had been lessened the same result might have been obtained, and the extra angle dispensed with. It is obviously cheaper to put in a 4in. than a 5in. pitch, say, if so doing will save the extra angle. There is, however, no information to show whether the extra angle acted solely by throwing the rivets into double shear, or whether it lent an additional stiffness as well. Presumably it did; if so, how much extra load would the sample as Fig. 1 have stood if it had had a closer riveting pitch?

In the experiments on intercostal side stringers the issue was whether in deep framing, if the intercostal plate be flanged by bending for fastening to the shell plating, it would be as strong as if attached by the ordinary angle. Figs. 2 and 3 show the two methods in section across the samples tested. It was proved that they were identical in strength, and also that if a deep angle was used, and a shallow plate, as Fig. 4, there was still the same strength present. In a couple of samples tested to determine whether small plates between the stringers would be as efficient as intercostals, the breaking loads for the latter were nearly 40 per cent. higher. Fig. 5 gives sections of some samples which were tried to test the efficiency of intercostals in preventing the frames from tripping. In these cases, with a length of 15ft. and a depth of 7in., it was found they did not add to efficiency, since tripping did not take place where no intercostals were fitted, even in the frames bevelled to 30 deg.; failure occurred in every case without tripping.

It is no surprise to find that a flanged plate gives as strong and effective a fastening as a connecting angle, always provided that the metal is of quality good enough to bend to a right angle without deterioration. We can regard so much as being now proved. Figs. 2 and 3 collapsed by the intercostal plates failing where slotted out for the frames, and also by the shearing of some of the rivets connecting them to the shell plating. Where the intercostal plates were discontinuous, however, the failure was by shearing of the rivets attaching the plates to the bottom angle bar. As there was the same number of rivets used in each, and the breaking load was so much less, this seems peculiar, and appears to suggest some small amount of racking, due possibly to the several short lengths of plates. The strangest results, however, are those in which it is recorded that the frames—Fig. 5, *b* and *c*—set to angles of 15 deg. and 30 deg., collapsed before they would trip. On the face of it one would say that they would trip under comparatively light loads, and that the presence of the intercostals would considerably stiffen them. Such a supposition has been entirely disproved; in the words of the report, "the fitting of the intercostal plate to the stringers did not add to the efficiency of the frames." We can only conclude that the proportions of the parts had been so nicely arranged that the riveting was in every way equal to the strength of the plates, and so successfully withstood the tripping action which most certainly must be present.

The last set of experiments, those on the efficiency of the rivet attachment of shell plating to frames, is rather disappointing, since it opens up a very interesting problem without giving any real clue to the solution. The question was whether when double reversed frames are fitted below the lowest deck in lieu of making the entire frame of greater depth, more stress was not thrown on the riveting attaching the frames to the shell plating. The results proved the truth of calculations, Fig. 6 failing before Fig. 7, there being, however, only a difference of about 10 per cent. in the breaking loads. In Fig. 6 the rivets attaching the frame to the plating sheared; in Fig. 7 the web fractured in way of the middle rivet hole. Fig. 6 is undoubtedly the stronger girder, and it is morally certain that if the ¾in. rivets had been pitched 4in. apart instead of 7in. this would have been conclusively proved; double reversed frames are a great convenience, and whilst the main object of the experiments was achieved, yet it is not placed on record that by an alteration of pitch the lesser depth gives the greater strength. A noticeable point is that on a span of about 8ft. 6in., ¾in. rivets, 7in. pitch did not collapse under a load of 67 tons, with scantlings as in Fig. 7. According to shear developed, and presuming this to be a central (?) load, such riveting would be totally inadequate according to our usually accepted girder theories. This it is impossible to enlarge upon however, since there is no information as to the exact span, and still less as to the method of loading. This, and the lack of sketches showing fractures, &c., constitutes a real drawback to the all-round usefulness of the report. Actual experiments on assembled structural members have been so few that if Lloyd's had seen fit to have given details of the testing ram used, the method of applying the loads, and of measuring intensities and deflections, the places and appearance of fractures, and full dimensions of all samples tested—had given, in short, a complete thorough record, valuable light might have been thrown on many outstanding questions, and the results would have been of great value in research work. As the report stands it fulfils the primary objects of the inquiry, having settled beyond dispute the few broad questions raised; perhaps designers will be apt to think that since mathematics had previously solved them satisfactorily, the money spent on the inquiry might have been made to yield a few more scientific facts.

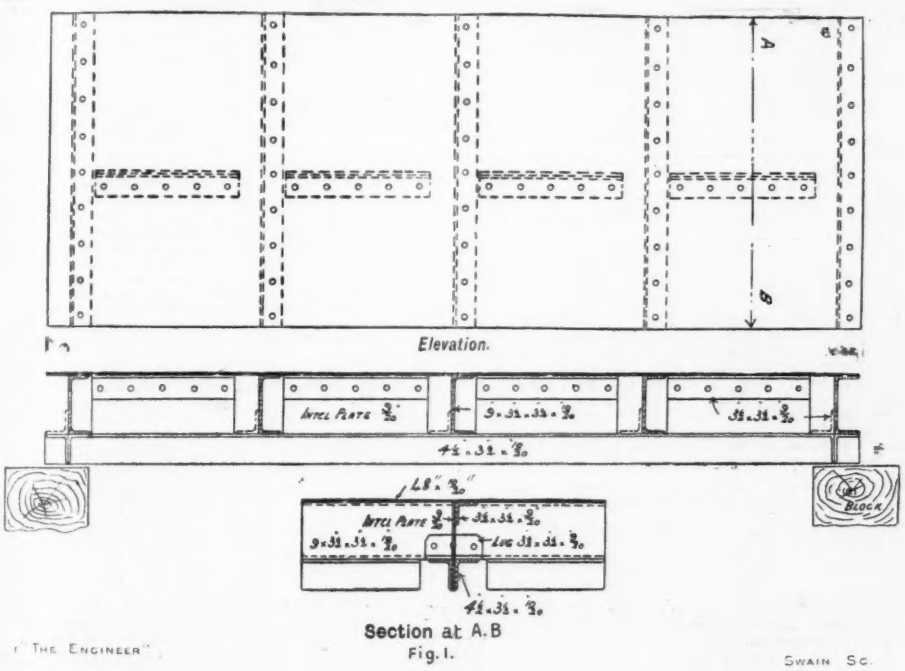


Fig. 1.

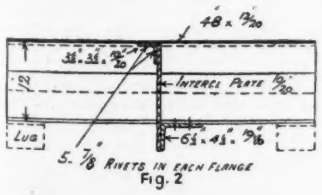


Fig. 2

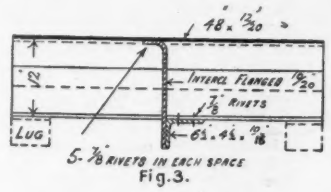


Fig. 3.

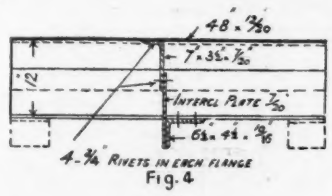


Fig. 4

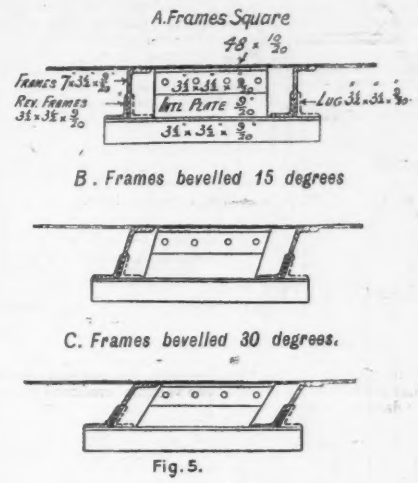


Fig. 5.

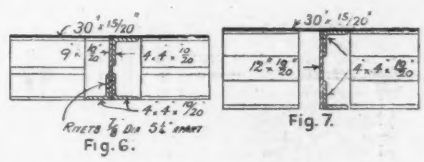


Fig. 6.

Fig. 7.

ROYAL METEOROLOGICAL SOCIETY.—At a recent meeting of this society, Mr. F. J. Brodie, F.R.Met.Soc., read a paper on the "Decrease of Fog in London during Recent Years." He had discussed the number of days of fog reported at Brixton, the London station of the Meteorological office, for the 33 years 1871-1903, and found that the mean annual number of fog days was 55, of which 45 occurred in the winter half of the year, and only 10 in the summer half. December is the foggiest month with 9·5, the next being November with 8·5, January with 8·2, and October with 7·8. The clearest months are July with 0·4, June with 0·6, and May with 0·8. The greatest number of fog days were 86 in 1886 and 83 in 1887, and the least, 13 in 1900 and 26 in 1903. Dividing the 33 years into three periods of 11 years each, the author showed that the mean for 1871-1881 was 55, for 1882-1892 it was 69, while for 1893-1903 it was only 41, there being thus a very marked decrease in the number of days with fog during the last 11 years.

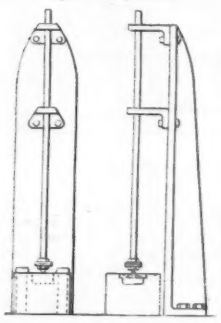
IMPACT TESTS ON THE WROUGHT STEELS OF COMMERCE.*

By Mr. A. E. Seaton, Member, of London, and Mr. A. Jude, of Birmingham.

The objects of this paper are to show some of the characteristics and peculiarities of the wrought steel as supplied by steel manufacturers for commercial purposes, to assist in the development of a more rational method of testing the suitability of such steels for each particular purpose of the engineer, and to point out a few of the peculiarities that are observed in the fracture of test specimens and actual pieces of machinery. It is, in fact, the outcome of the constant endeavour of engineers to avoid the use of material which might be dangerous in the construction of machinery liable to severe alternating stresses, and more especially to attempt to find the very best steel for those parts liable to shock, owing to the inability to make those parts larger in the very fast moving engines so much in demand to-day.

Considerable movement has been made of late towards the establishment of a shock test for steel, conducted on a smaller scale than is the custom with axles, for instance, where the full-sized article is tested. The authors are strongly of opinion that progress in this direction is taking place still too slowly, and it is therefore the aggregate object of this paper to help towards a further appreciation of this valuable test. All the experiments have been made on the ordinary steel, as supplied by various manufacturers as suitable for such parts. Some of the test pieces are from forgings such as crank shafts, connecting-rods, &c., and others from the bar steel supplied for stud and bolt making. In no case have they dealt with what may be called a "fancy" material, the product of laboratory melting-pots. The tensile tests have been made in a Buckton testing machine, while the shock tests have been carried out in an apparatus designed by the authors to require, as a rule, more than one blow to produce

Fig. 1.
"Impact" Testing Machine



"Impact" Test Bars.

Fig. 2.

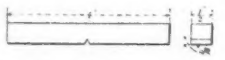
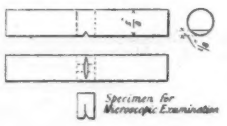


Fig. 3.



fractura. Such apparatus, as shown in Fig. 1, consists essentially of a weight of 6lb., arranged to drop freely through 24in. on to the test bar, Figs. 2 and 3, which rests on fixed supports 3in. apart. The test bar is 4in. long, so that there is ½in. overlap at each end. After each blow the test piece is reversed. In the author's opinion, the apparatus to test the endurance of a material under shock should not be one in which the sample is fractured at the first blow, especially for steels that are soft and are really very tough, although they admit that for some purposes such a test may be instructive and actually necessary for very high carbon steels For constructional purposes the engineer is not greatly concerned with steels with more than about 0·4 per cent. carbon. Although a large number of experiments have proved to them that in every case, and with every description of structural steel, the power to resist shock has been materially enhanced by oil tempering, they have confined themselves mainly to the examination of the material as supplied by the makers rather than after any heat treatment of their own.

At present everybody makes tension tests, and trusts more or less to them alone. One takes up an advertising or scientific article on, say, "Special Nickel Alloys of Steel," suitable for doing all sorts of wonderful things, and the first and the main thing one is expected to be impressed with is the superior tensile and elongation results One has occasionally yielded to the temptation to use such steels for which a very big price has been paid, but they have usually proved no better servants than ordinary material. A large majority of engineers rest content with tension tests alone, no matter to what use they are putting the steel—some, perhaps, because it is rather an expensive test, taking into consideration cost of plant, &c. It is sometimes stated, consequently, that an ordinary mild steel—say "Admiralty" grade—is not good for certain purposes, but that a particular "special" steel is perfectly safe, &c., because the elastic limit and tensile strength are somewhat better.

A similar assertion is made in the sixth report to the Alloys Committee in reference to heat-treated steel for guns. How much is this tensile strength and elastic limit thereby raised? The answer is, Anything from about 5 to 30 per cent.

The following are the tests that can be made on most pieces of metal, steel in particular:—(1) Tension and elongation; (2) compression; (3) cross bending; (4) hammering out to a point or thin edge; (5) fatigue by gradual reversal of stress either by bending in one plane or by rotation, as adopted by Wöhler, Professor Ewing and others; (6) the same, but with the stress uniformly distributed over the section, as suggested by Professor Osborne Reynolds; (7) impact on unnotched bars; (8) impact on notched bars; (9) chemical analysis; (10) micro-analysis. There may be variations of the above.

The general uses of steel may be divided into three main groups:—(*a*) Structural work subject to steady loads only, such as boilers, buildings, tanks &c.; (*b*) structural work subject to recurrent loads of one kind, at intervals, in addition to the load due to its own weight, such as bridges, &c.; (*c*) structures subject to rapidly repeated loads of one kind, all more or less suddenly applied, as with bolts and studs, rails, &c.; (*d*) structures subject to alternating loads, such as in the fixed and moving parts of machinery in general, and in many parts of a ship.

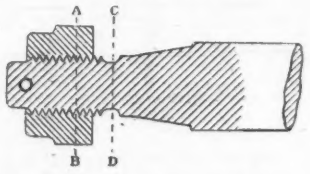
For the first two there is no doubt that the tension test is a good and sufficient one, as the predominant stress is certainly pure static tension, but it will be insufficient for the very heterogeneous groups (*c*) and (*d*). The question may then be asked, Which of the tests in the above long list is really a true universal gauge of the suitability of a piece of steel for any purpose it may be put to? As a help to answer this question, attention may be drawn to the following analysis of stresses in the steel parts of an up-to-date steam engine moderate size:—

	Per cent.
Constant tension	3·94
Constant tension and compression $\left(\text{range} \frac{0}{\text{max}}\right)$	1·30
Constant tension and shock	48·80
Alternating tension and compression with shock	2·81
Repeated tension (from a constant to max.) with shock	36·00
Miscellaneous and doubtful	7·17
	100·00

It will be seen that 87·6 per cent. of the whole engine is subject to more or less shock, while pure tension forms an insignificant percentage of the total stress; vibratory or alternating stress, where the transition from one kind to another is gradual (say, following a sine law), and unaccompanied by shock does not occur at all in normal conditions, although it may be conceded that, under ideal conditions, in the crank shaft, for instance, it will occur. This is in only one machine. If, however, various other machines are examined, it will be found that nine out of ten are working under similar conditions.

Referring to the steam engine, there are important parts, such as the piston-rods and connecting-rods, that, under ideal conditions of working, are subject mainly to direct alternating stresses. When, in the majority of cases, a piston-rod gives way, it breaks at the end through the line A B, Fig. 4, and not through the smallest area C D, supposing that happens to be less than the area at the bottom of the thread. In fact, it is dislocated through a section where the effect of repeated blows can accumulate. There is undoubtedly, in addition to the suddenly applied steam loads, a series of true though comparatively minute blows, with proper

Fig. 4.
Fracture of Piston-rods.

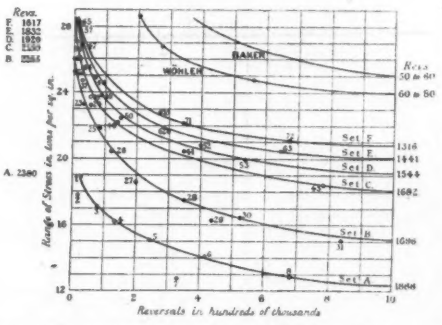


adjustment, arising from the necessary slackness in all the bearings.

The question may be asked, "Why do not this rod and similar pieces of machinery break in the same place by the accumulated effect of stress reversals or variations, just as well as with a series of blows?" It may be possible that they do so in some instances, but there are a few considerations which incline the authors to the opinion that this is not the case as a general rule.

Fig. 5 is taken from a paper by Professor J. H. Smith, read before the Royal Society.* Some of the members may have already

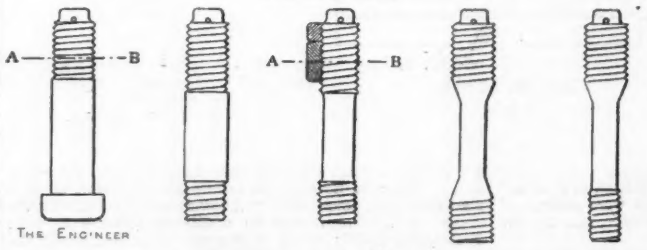
Fig. 5.—Mild Steel (Forged)
Diagram for Failure under Reversals of Direct Stress. (Prof. Smith.)



seen it. The authors are indebted to Professor Smith for its reproduction. The experiments on which this diagram was based were not made in the Wöhler fashion and as adopted by Mr. Stead, Professor Ewing and others, where reversal of stress is obtained by means of a rotation. Here the stresses were pure tension and compression distributed uniformly over the section, and not as in their experiments, with the maximum stresses at the surface The variation of stress practically followed the sine law.

There are also exhibited portions of some broken studs in which the working stress probably never exceeded 2¾ tons, and certainly

Fig. 6.
Fracture of Studs.



could not by the most extreme method of calculation have exceeded 4¾ tons per square inch. Some examples are shown in Fig 6, and to which the same remarks apply. The stress given above is the maximum, and the variation of stress was from the initial "nip-up" to this value. In no case did the rate of variation exceed 350 per minute, and the stresses were in all cases variable—that is, of the same sign—and not alternating, from + to −. The curves in Fig. 5 alone show that, with a range of stress anything below about 11½ tons per square inch, and with 1880 reversals per minute, it is impossible to break such a steel bar. The total number of variations in six particular cases of the broken studs was as follows:—

A	3,200,000
B	7,000,000
C	1,240.000
D	2,800,000
E	5,700,000
F	15,400,000

which represents after all only a short life of a few days in the case of some modern engines. From consideration of the relative speeds at which the variations were made, and the limiting condition as determined by the diagram, much more ought it to be impossible to break these studs by the mild "varied stress" treatment actually meted out to them. From the above two considerations it would appear reasonable to conclude that the effect of alternating or variable stresses of the magnitudes determined by the usual factors of safety, and especially in those cases where the stress is nearly, if not quite, uniform over the whole area—as distinguished from those cases where it varies, as in a beam from 0 to a maximum at the surface—is quite harmless. Something of a more searching nature must be looked for, and it seems as if it can only be shock—that is, a number of minute blows more or less persistently applied.

There have, no doubt, been many cases where mild steel forgings of this kind have, to all appearances, broken in an unaccountable way. In some cases under the author's notice the shanks of studs have been reduced very considerably, so that the area was only about one half that at the bottom of the thread. Yet without a single exception they all broke through the thread. In fact, some one or two of such studs have had for unavoidable reasons a larger thread at one end than at the other, but they broke through the larger thread and not through the smaller thread. More curious still, in at least three cases under their notice, a complete annular ring has broken between two adjoining threads; and further, these threads rarely break at the ends of the nuts, but in various places, often somewhere in the middle. In the case of those cut up for testing, the usual tensile tests were quite satisfactory, and in one or two where an analysis was taken of the metal close to the fractured surface, it was also quite satisfactory. But on being subjected to an impact test they all gave exceedingly poor results. For instance:—

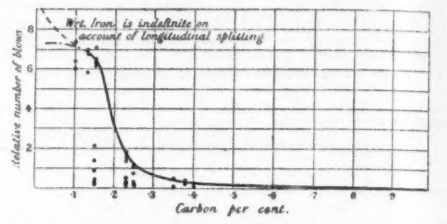
(A)	broke after	only 1	blow
(B)	,,	,, 13	blows
(C)	,,	,, 9	,,
(D)	,,	,, 7	,,

From numerous tests it is found that the average impact strength with this particular machine—Fig. 1—for Admiralty mild steel, ordinary forging quality is equal to about twenty blows. This would be for articles having scantlings of a few pounds. The maximum for the grade and for similar scantlings may be taken at about thirty. Thus, all these test specimens from broken articles gave results considerably below the expected average

There is yet a third point in favour of the contention that failure is by shock, and not by true alternating or variable stresses. It is well known that the resistance to alternating stress—rotation method—increases with the carbon content and elastic limit of the steel, but the resistance to shock decreases with an increase in those factors—for "normal" steel.

It has been found in a large number of instances that where fracture has occurred after a few hours' work when using normal medium grade steel—0·25 to 0·3 C.—this occurrence has been either greatly delayed or indefinitely postponed by the substitution of low-carbon steel, especially when in its best toughened—fine grained—condition. Therefore, apart from the question whether even

Fig. 7.—*Curve of Maximum Shock Strength of Commercial "Pearlitic" Steels.* (Forged or Rolled Quality.)



thirty blows given by this particular machine is a good and sufficient insurance against fracture, the point is that it is not satisfactory to subject all steel to one particular test, just because that test may be a suitable one for large quantities of it for one particular purpose. Let there be these particular tests for bridge steel and boiler steel by all means, but steel that will be used for the miscellaneous forgings of machinery in general should be tried by its own crucial tests. Car axles, cranks, and similar articles perhaps should be subjected to an alternating stress by the rotation method, instead of by the shock test, as in their case also the tension test is almost useless as a gauge of the suitability of the material. Professor Ewing and others have shown most conclusively that the resistance to an alternating stress of the kind adopted in their researches bears no relation to the resistance to pure tension.* There is plenty in each of the aforementioned groups of the uses of steel to warrant different testing methods when necessary.

Reverting to the question "Is there for groups (*c* and *d*) in particular one comprehensive test for steel forgings?" The following appears to be the practical answer:—"Simple tension" is not. "Bending" is not sufficient. "Impact" on plain bars is doubtful—certainly too tedious if without distortion. "Reversal of stress" by either method—before described—is fairly good, but "impact on a notched bar" is best of all: First, because it appears to be a gauge of the preponderant stress (It is doubtful whether "stress" is the proper term to use; "dislocating agent would be better, although even this is hardly correct, as will be shown in Part 2). Secondly, because experience shows that, with absolute certainty, there is always a good enough ductility when there is a good resistance to shock. But it is known equally well that there may be obtained an excellent tension and elongation result from steel which is quite incapable to resist shock. Thirdly, because 99 per cent. of all forgings are notched in some way or other, not necessarily with a V nick. Moreover, sharp edges, internal and external, cannot always be avoided in machine design, or even deep scratches in actual construction.

It must not be concluded that the factors of elastic limit, &c., are despised, but since the forces that cause breakage are, in practice, far below the elastic limit in magnitude, and, moreover, as the factor of safety is quite arbitrary and the same in no two pieces of machinery, it seems to the authors that the cart is put before the horse to a great extent. In fact, under the usual conditions of design, one knows enough about the elastic limit, which can only vary in a given grade of steel between comparatively small and insignificant limits, whereas the shock strength can vary almost between infinite limits.

From the very many bars that have been tested by the authors, they have found the number of blows to produce fracture is a fair gauge of the toughness or anti-brittleness. But there is no relation whatever between this result and the tensile results, except what has previously been mentioned, namely, that if the impact result is good, the elongation is sure to be good too; but, on the other hand, a steel showing high tensile strength and good elongation may be useless to resist shock. For example:—

		Tension. Tons per sq. in.	Elongation. Per cent. on 2in.	Impact. Blows.
Cold-drawn bar of very low (less than 0·1) carbon steel	(*a*)	31·63	31	1
	(*b*)	31·27	20	180
Low carbon steel (0·15 C.)	(*a*)	28·3	37	175
	(*b*)	27	33	5
Medium carbon steel (0·25 C.)	(*a*)	36·5	35	5
	(*b*)	36·5	35	27
Mild cast steel (0·35 C. about)	(*a*)	29·18	22·7	1
	(*b*)	28·25	31	1

Although there is no relation between the tensile-stress test and the alternating-stress test, or between the tensile test and the shock test, the authors are not prepared to say that there is no relation between the alternating-stress test and the shock test. They will, indeed, be glad to learn that there is a close relation, since then the controversial ground as to the nature of the forces,

* The Institution of Mechanical Engineers. Abstract

* "Proceedings," Royal Society, 1902, vol. 199, page 265.

* *Journal*, Iron and Steel Institute, 1903.

"alternating" or "shock," is at once eliminated. They think it possible that a relation does exist, because, although there are differences in the disturbance of the metal in the vicinity of the fracture, the radical phenomena—"dislocation" and "cleavage"—are the same. A short consideration of these phenomena is given in Part 2.

The majority of steel users require that they shall be able to use an ordinary steel as supplied to them, and without annealing, tempering, or other heat treatment. The authors, therefore, urge that the engineer should demand of the steelmaker a greater attention on his part to produce and supply the ordinary grades of steel with a more uniform "shock" quality.

Photographs, thrown on the screen, were used to illustrate the structure of steel. It is, of course, to be expected that brittleness in steel increases with the carbon content, but the authors are convinced that the falling off in this respect is far more rapid than the majority of engineers are aware of. And further, they believe that this has been in a great measure unobserved, owing to the prevalence of the tensile as the only test; and they are also led to this by the fact that the very toughest "fancy" steels—as distinguished from the natural or normal pearlitic steels—are often produced from what is more or less equivalent to high carbon steels, such, for example, as the nickel alloys, where the ferrite is almost wholly displaced by a composite mixture.

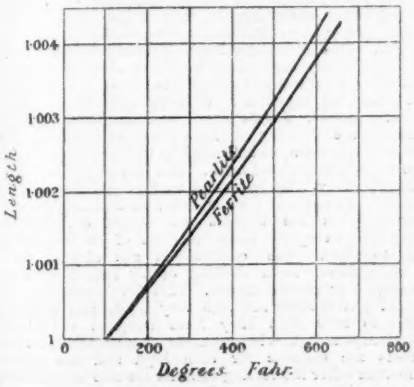
The authors have come to the conclusion that, given a certain percentage of carbon in steel (1) it is impossible in any given mass to produce a grain below a certain size and still preserve the eutectic as pearlite. (2) There is a minimum brittleness upon which it is impossible to improve while still retaining the pearlite eutectic. (3) This brittleness increases very rapidly with the increase of carbon, especially at or about the "mild" region.

From the results of numerous experiments, they arrived at the results shown on diagram Fig. 7, which gives approximately relative values of minimum brittleness or maximum toughness under shock. For instance, it may be expected that with articles of approximately the same scantlings and in their pearlitic condition, those having 0·2 per cent. carbon will be five times tougher to resist shock than those with 0·3 per cent. This diagram is intended to apply to forged or rolled steel and not steel castings—at any rate, not such as usually supplied. Since in a "saturated" steel the line of fracture is necessarily through pearlite, an exceedingly brittle substance compared with ferrite, the next natural conclusion from this is that the line of fracture will be in all cases through as much pearlite as it possibly can. There also appears to be yet a prevalent idea that fracture of any kind takes place more or less along the crystalline grain junctions.

The series of photographs thrown on the screen showed:—First, that in any grade of steel of the range under consideration, the line of fracture does not go through as much pearlite as possible; further, that it distinctly avoids doing so, but really goes through as much ferrite as possible. Secondly, that fracture through the ferrite crystalline junctions is extremely rare, and really is practically always through cleavage planes.

The authors have also observed that the fracture through pearlite is not junctional, that is, between the lumps; neither is it, as a rule, parallel to the laminations, but appears to follow an erratic course both in saturated and under-saturated steels; in the latter the controlling agent is evidently the ferrite, but in the former the reason is obscure. This, however, is outside the limits of the paper in view of the above two statements, but it adds weight to the appreciation of the obstinate action of pearlite. It will thus be seen that by the first statement above, there is a contradiction to the second natural conclusion arrived at—above—that fracture would of necessity take place through a maximum of pearlite. There is also an apparent contradiction to the first natural conclusion that increased brittleness is the outcome of an increase in the quantity of pearlite. To this latter it is obvious, of course, that there is no real contradiction, seeing that carbon is the only variant.

FIG. 8.—*Expansion (Linear) of Pearlite and Ferrite.*



The distinction between fracture by true alternating stress and by shock is not quite clear in sections taken from the interior of the article. Since there is little or no drawing out of the crystalline grains, it follows that separation by consecutive or progressive slipping will not be nearly so drastic as in the case of the tension specimen. It should therefore be much more difficult to obtain a slip-band appearance by etching a specimen broken by an alternating stress considerably below the electric limit. Nevertheless, on comparing the two specimens, it appears that the fracture by alternating stress is accompanied by small cracks and fissures in its immediate vicinity to a much greater extent than is the case with the fracture by shock. Further, slip bands—or minute parallel fissures—are often visible close to the edge of the alternating fracture, but they have never been discovered near a shock fracture.

In general, therefore, the remarks in this connection apply to test specimens. The authors have, as have been seen, plenty of articles broken by what they believe to be shock, and there appears to be a perfect identity between the microscopic appearance of the fracture of these articles and their test bars broken by shock.

The results are summarised as follows:—(1) Impact test-bar fracture is through ferrite, and has no slip bands; (2) fractured bolts, &c., show no drawing out or slip bands; (3) alternating stress—rotating—test-bar fracture is through ferrite, with external slip bands in profusion, and internal slip bands sometimes visible, but there is no drawing out of crystals; (4) tension test-bar fracture is accompanied by slip bands in profusion, and with the crystals very drawn out; (5)—(from Part I.)—fracture by direct intermittent stress is highly improbable. The only conclusion that seems possible from the above is that the fracture and method of producing the fracture is of a similar nature in the articles that break mysteriously and in the impact test bars broken by a number of blows, that is, by a spreading crack.

The authors having conceded the admitted existence of three critical temperatures, say of the sectional period:—It is highly probable that there are changes of volume of the components that take place simultaneously with the chemical or allotropic changes, whichever may occur; but the range of temperature is small and the volumetric changes of the components will be sudden, so that either there will be approximate mutual action or else gaps will be formed. The former seems to be the more probable, as there is no evidence of any gaps under the microscope, and their existence is not confirmed by any of the peculiar ways steel fractures under various forces. Further, the phenomenon of expansion during plasticisation at the higher temperatures may be present in the carbon-laden components at their lower plasticisation temperatures. But between the first and cold there is a very long period when the pearlite is constantly contracting at a different rate from the ferrite.

Supposing that the authors' relative coefficients of expansion—Fig. 8—correct, then, since the pearlite is contracting at a greater rate than the ferrite, it means that it is acting as a sort of hydraulic expander to the ferrite instead of a hydraulic press, and this effect will increase with the increase of carbon. There would therefore be an increasing tendency to hollowness in each individual ferrite grain in much the same way that a piece of lead, for example, sinks down when cooling, and with this tendency they think it is quite reasonable to suppose that there is a corresponding tendency to easy separation through the grain either individually or in series. And in the case of the higher carbon steels, where the quantity of ferrite is small, there would alternatively be an increasing tendency to separation between the ferrite and pearlite.

A deduction is therefore arrived at that harmonises the apparently anomalous facts that the line of fracture avoids going through pearlite; that the line of fracture avoids going through the junctions; and that brittleness increases with the carbon content. And, further, the larger the crystalline grains the greater the weakness, which is not only confirmed by their numerous test bars examined, but by the intensely brittle results that are produced by long annealing. Supposing that the coefficient of expansion of ferrite be greater than that of pearlite there would still be the tendency to openness in the ferrite, but it would be a decreasing tendency with the increase of carbon. On the whole, therefore, the authors think their experiments and observations are confirmatory.

In the foregoing, the subject-matter has been strictly confined to the strength, &c., of steel in its natural condition, or that condition produced by the comparatively slow cooling process of ordinary manufacture. The shock strength of "treated" steels, however, is a matter of equal, if not greater, importance "Treated," means any process whereby the steel is left in a more or less artificial condition as distinguished from the natural condition just discussed, such as oil-hardening, water-hardening, tempering, and allied processes. The authors have not had the time nor facilities for conducting a complete series of experiments with these steels, but they have done quite sufficient to be assured of the fact that the shock strength of oil-quenched mild steels particularly is not increased a mere matter of 20 per cent. (720 deg. Cent. in oil, 0·25 deg. Cent.) to 130 per cent. (1200 deg. Cent. in water), as is the case with the tensile strength, but on an average 500 to 600 per cent. more than the shock strength of the natural steel in its best condition. Moreover, oil-quenching appears to possess the highly important property of "levelling up" the shock strength of steel to a fairly constant value.

Thus there may be two similar articles made of the same grade of steel, the one coarse and brittle and the other fine and tough, and possessing a maximum shock strength. Oil-quenching will increase the strength of both to a common value, the increase in the one case being, perhaps, several thousands per cent., and, in the other, the 500 or 600 per cent. above referred to.

They think that practice with such things as gun barrels shows this also very clearly, and they have no hesitation in saying that whereas the tensile testing machines practically make no distinction between the steel that is utterly unfit, and that which is eminently fit for the parts of a machine subject to shock or vibratory stresses, the drop testing apparatus does most certainly, and without fail, make the discrimination; and further, that wherever the drop testing machine shows a steel to be good, the tensile testing machine corroborates it. Therefore, it may be concluded that while the drop testing machine is a certain and reliable guide to the maker of such structures, it is equally the friend of the construction of other structures, subject only to tension or compression steadily or constantly applied.

Attention is particularly drawn to the shock strength of bright rolled bar. It is a remarkable fact that, until quite recently, all the bright bar on the market, with the exception of about two British makes, appeared to be quite rotten under shock, snapping off in all cases with only two or three blows, and not improving very much by oil-quenching. The authors have not had occasion to obtain analyses of the numerous samples of bright bar they have tested, but in the majority of cases the carbon content was stated to be from 0·11 to 0·15 per cent.

In those samples which met in other respects the Admiralty specification, the shock strength was worse than that of lower grades. The reason for the generally inferior results may be due to the drastic rolling process, but the fact remains that good bars can be produced with certainty by a few makers. They are, however, glad to observe that other makers are rising to the occasion, and that improvement is rapidly being effected, and without the accompaniment of a prohibitive price. They would, nevertheless, recommend due caution on the part of those using the larger sizes of bright bar for important parts of machinery. The number of blows that good bright bar will stand appears to be about the same as for ordinary bar of the same grade.

MIDLAND INSTITUTE OF ENGINEERS.

THE Midland Institute of Mining, Civil, and Mechanical Engineers met on the 8th inst. at the Royal Victoria Station Hotel, Sheffield. The large company included representatives of the Yorkshire Colliery Managers' Association. Mr. T. W. H. Mitchell presided over the meeting, and said that when he took up the duties of secretary in 1890 the number of members was 174, and the output of minerals in Yorkshire for the year ending December 31st, 1889, was 22,475,749 tons. At the end of the last financial year they had a membership of 305, and the output for the year ended December 31st, 1903, was 29,168,792 tons. They had now one member for every 96,000 tons raised, as compared with one member for every 1,291,000 tons raised in 1890. Referring to the different opinions given with respect to the British coal industry, Mr. Mitchell stated that the subject was entirely one of £ s. d. The better seams would always be worked first, and, in his opinion, nobody could appreciate to the full the mining wealth of the country at the present time, for the exhaustion of one seam seemed to produce an extra exertion on the part of workers and users for dealing with the next best and, most probably, deeper seams. Mr. Mitchell dealt at some length with the question of rescue work, and, with reference to the pneumataphone and other appliances which would enable work to be carried on in a noxious atmosphere, said he believed most of them would shortly be asked to take up this question financially and practically. Mr. M. H. Habershon afterwards read an interesting paper on "The Work of a Joint Colliery Rescue Station." Groups of collieries or pits in the same neighbourhood, it was urged, should have at hand, and always available, means by which a small number of trained men would be able to penetrate a noxious atmosphere for the purpose of exploration and to perform such work as the fixing of shafts or temporary stoppings, opening or closing doors, and the carrying out of injured or helpless men. For this it was necessary to provide improved pneumetaphors, portable electric lamps, and a station at which men could be regularly trained, oxygen and other necessaries kept, and the apparatus maintained in proper order. A building such as described had recently been erected jointly by the Barrow Hematite Steel Company, Messrs. Newton, Chambers and Co., and the Wharncliffe Silkstone Colliery Company, in a central position, conveniently situated for their respective collieries. Mr. Habershon described the apparatus known as the Giersburg pneumetaphor, which has superseded the Meyer helmet in this work. The experience of twelve months' practice at each of the three subscribing collieries had pointed to the need for combined action, or an instalment sufficiently large to ensure that all the apparatus be maintained in perfect condition, and so that there should always be a man at hand thoroughly conversant with every detail of the apparatus and its use. No difficulty had been found in getting suitable men to wear the apparatus and to practise until they could wear it a reasonable time, and he expressed the view that the result would be well worth the trouble and the slight expense involved.

The annual dinner, held in the evening, was attended by representatives of the mining, engineering, and allied professions of Yorkshire and Derbyshire. The toast of "The Mining Interests of the Country and the Coal Trade" was proposed by Mr. Sam. Fay, general manager of the Great Central Railway Company, who said that the prosperity of railways, particularly railways such as the Great Central, was bound up with the coal trade. They got one-third of their revenue from it, and they could not do without it. Mr. W. E. Garforth, Altofts, responded. Mr. G. B. Walker, J.P., in proposing "H.M. Inspector of Mines," paid a high tribute to the work done by Mr. W. H. Pickering, H.M. Inspector for Yorkshire, who is about to take up an important position in India. Mr. Pickering responded. Professor O'Shea, of the University College, is succeeding Mr. Mitchell as secretary of the Institute.

PREVENTING COLLIERY CAGE ACCIDENTS.—Mr. W. H. Cryer, an engine tender employed at the Tinsley Rolling Mills, Sheffield, is reported to have invented a means of preventing the accidents which occur in colliery shafts through the breaking of the ropes by which the cages are lowered. By Mr. Cryer's invention it is claimed that as soon as the rope breaks the cage is brought to a dead stop; further, that the heavier the weight upon it when the break occurs the more certain is it that the cage will be held until the rope can be repaired. Mr. Cryer has never had anything to do with coal mines, but he has been deeply interested in the accidents which have been caused through cages falling, and this has set him to study preventive appliances in the leisure left after following his ordinary occupation

THE TARIFF COMMISSION.—The Tariff Commission has held four meetings during the past fortnight at the Whitehall Rooms, under the chairmanship of Sir Robert Herbert, G.C.B., making seventy-five sittings to date. At the last four meetings evidence was taken in regard to the engineering, building, furniture, and textile trades. The witnesses examined in each section were as follows:—Engineering: Mr. John McLaren, J. and H. McLaren, Midland Engine Works, Leeds, engineers; Mr. George Cradock, Geo. Cradock and Co., Wakefield, wire drawers and rollers. Building: Mr. J. Howard Colls, Colls and Sons, 5, Coleman-street, E.C., builders and contractors. Furniture: Mr. W. H. Grenfell—M.P. for the Wycombe division of Bucks—made a preliminary statement on the history and development of the trade of High Wycombe and district; and the following witnesses were examined:—Mr. Walter Birch, William Birch, Limited, High Wycombe, and 370, Euston-road, London, chair manufacturers, cabinet makers, and upholsterers; Mr. Charles Skull, W. Skull and Sons, Limited, High Wycombe, and 45, Berners-street, W., chair manufacturers, cabinet makers, and upholsterers. Textiles: Mr. James Mackay, Palmer and Mackay, Trowbridge, woollen manufacturers; Mr. H. Lovell Hewitt, Kemp and Hewitt, Limited, Innox and Silver-street Mills, Trowbridge, woollen manufacturers; Mr. Alfred Sykes, Joseph Sykes and Co., Limited, Brockholes, near Huddersfield, woollen manufacturers.

GOLD COAST RAILWAY.—Mr. Allison Smith has been appointed locomotive superintendent for the Gold Coast Railways, West Africa. He will hold his position directly under the Colonial-office. Mr. Allison Smith was formerly locomotive superintendent to the New Zealand Government Railways, in which capacity he designed and built the extensive locomotive workshops at Addington, near Christchurch, the principal establishment of the kind in the Colony. Locomotive building is now carried on to a large extent in the Addington workshops. Subsequently Mr. Allison Smith held the same position on the Victorian Government Railways (Australia), where also he designed and built the workshops, and where he entirely reorganised the service, establishing large reforms in method and discipline, particularly in the standardisation of stock, which avoided the necessity of keeping large stocks of duplicate parts, the result being very material economies. Later Mr. Allison Smith acted as consulting engineer in connection with the designing and construction of the vast locomotive works for the railways of West Australia. Since his return to England he has brought out the automatic buffer coupling—or A B C system—of automatic couplings which he invented some years before, and which is now being tried in this country and elsewhere with, we are told, very favourable results. Mr. Allison Smith is to leave England on the 3rd December to enter upon his new duties.

ROYAL ARSENAL ASSOCIATION OF FOREMEN, WOOLWICH.—The first of the series of papers to be given during the coming session before this association was read by Mr. J. Pickin, of Alfred Herbert, Limited, tool makers, Coventry, on the 15th inst., Mr. F. Penny, president, being in the chair. His subject was, "Examples of Modern Machine Work," and in dealing with it he found occasion to enter fairly fully into the big question of workshop organisation. Special prominence was given to the necessity of inter-operation examination in the machine shop, as effectually preventing any further labour being wasted on a spoilt job, also ensuring that the machine hand at fault renews the spoilt part. After touching on the various machine tools, and showing the methods by which certain jobs were finished accurately and economically on them by the use of ingenious jigs, he went on to speak of the advantages of a tool store. When this department is well equipped and the distribution of tools well organised, the machine hand does not require to grind his tools, nor to leave his machine to obtain new ones, the tool being ground by the tool room staff and distributed by messengers. The turret lathe naturally engaged a good deal of the lecturer's attention. He said that while no work was too difficult for the modern turret, as great a degree of accuracy was obtained as in the ordinary lathe, with less tax on the skill of the operator. Also, on this machine, unlike the full auto, it was not necessary to have big batches of work before the job could be turned out economically. It was common practice to set a machine for as few as six pieces, the difficulty of setting being met by fixing a setting price, thus making the number of pieces to be machined immaterial to the operator. By means of lantern slides, Mr. Pickin went on to show various jigging operations, a feature of which was the disregard for expense in the manufacture of the jigs, which would only be justified by very large orders. Having laid stress on the advantage of the polishing shop, where rough, round articles were brightened on a polishing machine, costing one-twentieth of the lathe on which this work was too often done, the lecturer brought his paper to a close by showing a few examples of jobs on which enormous saving had been effected by transferring them from the turnery to the turret shop. Discussing the paper, Mr. J. B. Wood suggested that such perfect workshop organisation as that described by Mr. Pickin would entail considerable indirect charges, and might easily lead to the works being overstaffed. He further said that where shop prices were fixed by an office staff, the estimator had to consider the time for fixing a job as well as the actual machining time, and this called for highly trained and intelligent rate-fixers. These last, he seemed to think, were rare birds. Replying to Mr. D. W. Bremner, who sought information on the question of lubrication, the lecturer's experience pointed to the use of lard oil for working on tool steel or on the full autos, and one of the patent soluble oils on the semi-autos, where lack of lubrication of any part could be at once detected by the operator. A vote of thanks to the lecturer, moved by the chairman and warmly seconded by Mr. C. White, concluded the meeting.

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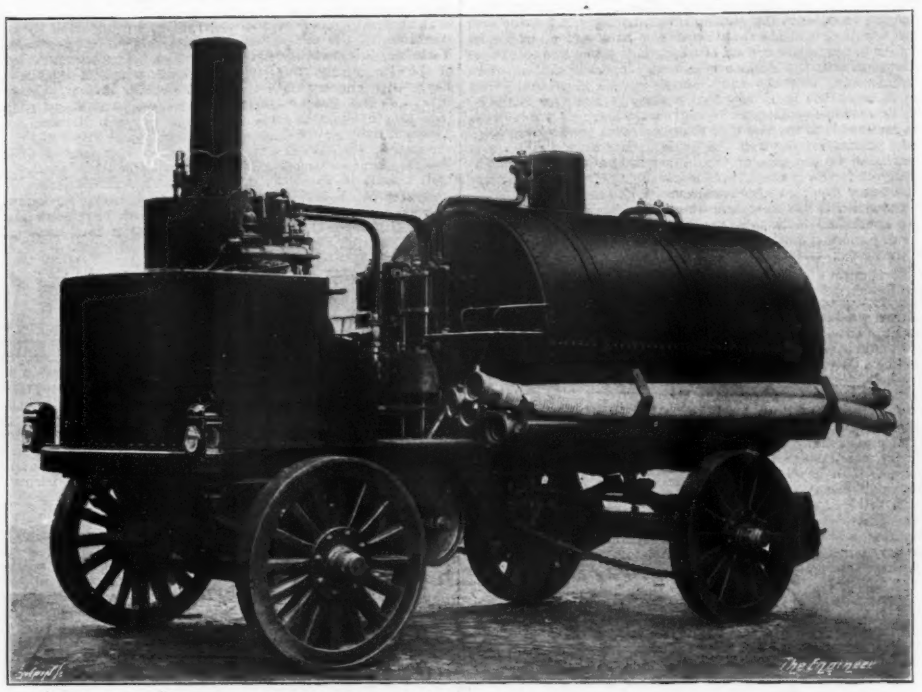
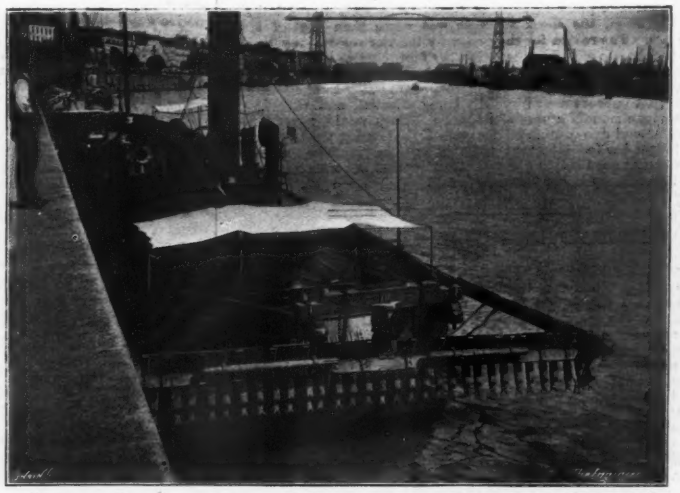


VACUUM CESSPOOL EXHAUSTER.

For some time now Messrs. Merryweather and Co. have been making vacuum cesspool exhausters arranged to be drawn by horses. The pumps for these machines had formerly to be worked by hand. This firm has recently considerably modified and improved the old method by introducing motor power, instead of horses, for traction purposes, and for driving the air pump. The action of the apparatus is simple. A large tank from which the air has been exhausted by a pump is connected to the cesspool by means of flexible piping. Upon opening a valve in the tank to which the piping is fastened, the contents of the cesspool is drawn up into the cylinder, without coming into contact with the atmosphere. The accompanying illustration shows the latest type of machine. The engines, boiler, pumps, and tank are all contained in the same carriage. The framework is constructed with channel irons, having steel cross stretchers shaped to carry the tank and boiler, and is carried on ordinary plate springs mounted on artillery wheels, having 5in. steel tires. The tank in the new machines is of the same type as has always been used, and is made up of galvanised steel plates riveted together. It has a capacity of 700 gallons. It is fitted with a manhole for cleaning purposes, depth gauge, air exhaust valve, vacuum gauge, and a full-way valve, screwed for taking the piping. The latter is made of galvanised steel, 4in. in diameter, and has gun-metal screw connections at each end. When not in use the piping is carried on brackets at the side of the tank. The motive power is obtained from one of the makers' ordinary 25 horse-power fire engines, with cylinder 7in. in diameter, and 4in. stroke. Placed immediately above the cylinders, and tandem with the engines, are two double-acting air pumps, with cylinders 6½in. diameter, for exhausting the air from the tank. These pumps are capable of creating a vacuum of 25in., and when the apparatus is working they can, it is stated, maintain 15in. vacuum. As the engine and pumps are in tandem, the latter are always removing air from the tank, so that by the time the machine has moved from one place to another, a vacuum has been created. The exhaust air is passed into the fire-box of the boiler, so that there should be no objectionable result on this account. The ratio of the gear from the engine to the countershaft containing the differential gear-box is 2 to 1, The power is transmitted to the driving wheels, which are 3ft. in diameter, by a Brampton chain, from two sprocket wheels at the end of the countershaft. The boiler is one of Messrs. Merryweather's quick steaming type, as used in their fire-engines, with the exception that the water space and tubes are larger. It works at 120 lb. per square inch pressure. The boiler is suitable for either oil or coal fuel; the latter method is usually adopted for this class of work. A hauling gear has also been fitted, so that soft ground may be traversed, if necessary. The gear consists of a drum with toothed gearing at the side, carried on two brackets fixed to the frame immediately under the engine shaft. The little pinion that gears into the large wheel on the countershaft is free to move along on its shaft, and can be brought into gear with the drum by the action of a lever. The total weight of the vehicle when fully loaded is 7¼ tons, and it is capable, so we are informed, of travelling about 12 miles an hour on the level, and of mounting a gradient of 1 in 11 at 5 miles an hour when fully loaded. The machine, besides emptying cesspools, can be used for such work as cleansing thoroughfares, where the mud, instead of being swept to the sides of the streets, is washed into gully-holes. It can also with very little trouble be turned into a water cart. The makers claim for this vacuum exhauster that it is absolutely sanitary; that it can be worked at a considerable distance from the cesspool; that it saves both time and labour; and that it can be operated during the day-time without giving the least offence.

RAKING A RIVER.

The Loire is a capricious stream. Its banks shift, and there is constant tendency to silting up. Vessels drawing 18ft. can reach Nantes at any time, and during high tides those drawing 23ft. can do so. In the winter of 1902 the Loire was filled by the greatest flood known for one hundred years. It is now as low as it was in 1822. The incoming tide carries sand and mud, which is deposited at slack water, and is not removed again because the river is too low to cause scour. To preserve the channel the Public Works Department has fitted a steam mud barge with a rake 36ft. long and weighing about 2½ tons. During the ebb the barge moves up and down the river, dragging the bottom and loosening the silt and mud, which are carried away by the tide. The accompanying engraving shows the rake hauled up at the stern of the barge. The scheme has, we understand, proved quite successful.



RAKING DREDGE ON THE LOIRE

Experiments have been begun at the Naval Proving Ground at Indian Head with several new kinds of bands for the large projectiles used in the big guns of the navy. It is believed by the strengthening of the bands tumbling of the projectiles can be prevented. The question was referred to the Special Board on Ordnance, and at the instance of this Board experiments at Indian Head were begun.

THE GAS EXHIBITION.

A Gas Exhibition organised by the Institution of Gas Engineers, was opened at Earl's Court last Saturday afternoon by the Lord Mayor of London, and will remain open until December 17th. This is the first international and representative Exhibition organised by the Gas Engineering Industries, held since that at the Crystal Palace in 1882. Stimulated by the keen competition of electricity, both for lighting and other purposes, gas engineers have made great headway within recent years, and it is a significant fact that in ordinary lighting the illuminating effect is thirty times as great as it was in 1882 for the same quantity of gas. Every effort has been made to ensure success, and as far as the exhibits are concerned, the management are to be congratulated on the result obtained. The exhibits are numerous and representative of what is being done in this direction at the present day, and they include gas cookers, heating stoves, incandescent lighting, artistic fittings of all descriptions, meters, and all classes of machinery which are either worked by, or used in the production of, gas. It is the latter class in which we are most interested. Messrs. Bryan Donkin and Clench, Limited, Chesterfield, are showing a new rotary compressor for high-pressure gas distribution driven by a small gas engine, having a neat apparatus. They are also showing a gas exhauster coupled to a vertical steam engine, a calorimeter for testing coal or coke, and their latest valves. A special feature of the show is the fine series of models that are shown illustrating large apparatus that cannot be placed in the space provided. Messrs. Babcock and Wilcox, Limited, Renfrew, have on view a silent gravity bucket conveyor for coal, coke, ashes, &c., with the driver in motion, showing the method of working the conveyor without sprocket wheels. The arrangement of buckets and chains, with rails, supports, and discharging appliance, are also shown. Another very interesting model is that of a Temperley travelling tower transporter, made by the Temperley Transporter Company, 72, Bishopsgate-street Within, E.C., for carrying chiefly coal or coke. The conveyor is built on a steelwork cantilever principle, the long arm ranging from 30ft. to 100ft. in length, and the shorter one being made to suit requirements. The skips hold 25 cwt. of material, and travel at a speed of 600ft. to 700ft. per minute; they can also be raised or lowered at 250ft. per minute when full. The whole installation runs on rails, and therefore has a large range of action. One of the most important points in connection with this transporter is that the skip can be lowered before dumping the contents, and consequently the chance of breaking the material is reduced to a minimum. Messrs. A. B. Gibbons, jun., Limited, and Messrs. Gibbons Bros., Limited, are showing a selection of fire-bricks and tiles used in their settings, and also in various sections and sizes of retorts, with their particular seam of fire-clay. They are also showing all classes of retort setting, constructed on generator and regenerator principles, and elevators and conveyors showing patent steel roller chain for transmitting power and materials, from 3·3in. to ·25in. pitch. Messrs. The Thames Civil Engineering Works, Canning Town, London, are exhibiting a large Hone's patented grab. It has been designed for dealing with coal, coke, lime, &c., and the cost of handling the material is given at about 1d. per ton. They are supplied in different types to suit requirements. Messrs. James Keith and Blackman Company, Limited, are showing an interesting automatic gas compressor in operation, which is usually worked by water pressure from the ordinary street main. The ordinary pressure of gas is increased by this apparatus to 8in. water gauge. The pumping bell works in a water seal, and is entirely automatic, starting when the burners are turned on, and regulating its own speed to the amount of gas required from time to time. The compressors can also be adapted for being driven from shafting or by means of a small gas engine or electric motor. This firm's ordinary incandescent gas burners are also very good, and it is interesting to note that they have supplied a number of these lamps to light a large section of the Exhibition. These burners are suitable for both high and low pressures. Numerous other interesting exhibits are also being shown by the firm. There are several firms exhibiting ordinary meters, all of them being more or less of the same type. Messrs. George Wilson, Coventry, have a large selection, which includes a station meter with a capacity of 5000 cubic feet per hour, fitted with a cylindrical tell-tale jumping index; prepayment meters for England, Holland, or Germany; dry meters and wet meters. Messrs. Drakes, Limited, Halifax, are exhibiting a model of their retorts, and also elevators and conveyors, and sight boxes of various types. The castings shown by this firm are very good and worthy of special notice. Messrs. Graham, Morton are showing five different types of elevators and conveyors, all in motion, and handling two tons of material. A number of the well-known firms of gas engine makers are exhibiting, but there does not seem to be any particularly new feature in any of them. Messrs. Hardy and Padmore have several of their vacuum engines working small fans and pumps, the sizes ranging from 1½in. to 6in. bore. They are also showing their new vacuum engine, in which the flame is obtained from petroleum oil instead of gas. They are also exhibiting one of their ¼ horse-power Ideal gas engines. Wilton's patent furnace is being exhibited by the Chemical Engineering Company, 79, Mark-lane, London. It is adaptable to steam boilers of all types, and many advantages are claimed by the makers for it. The Gas Light and Coke Company is showing an exceptionally large variety of fittings, and is displaying samples of the various chemicals obtained from tar, ammoniacal and cyanogen liquor, which, together with coke, are the principal residual products of coal gas manufacture. Those who are in any way interested in gas cannot fail to appreciate the Exhibition, which is well worth a visit.

The Institution of Civil Engineers: Yorkshire Students' Association.—The opening meeting of the new session of the above society was held at the Law Institute, Albion-place, Leeds, on November 17th. Mr. W. J. Cudworth, M. Council Inst. C.E., who has been president of this society for the last two years, is now succeeded by Mr. Ewing Matheson, M. Inst. C.E., who gave as his opening address a *résumé* of the various and principal works on which engineers are engaged. Railways, canals, harbours, docks, and bridges were dealt with, followed by municipal works of water supply, gas lighting, electricity, and tramways. In each of these subjects the lecturer summarised the advances made in recent years, and pointed out the wide scope for further improvements open to young engineers. He then exhibited a number of interesting slides of conduit tramways in London, bridges of various kinds and a few specially interesting views of the Victoria Falls on the Zambesi, showing the new bridge now in course of construction. A hearty vote of thanks brought the meeting to a close.

THE PATENT RULES, 1905.

We give below a reprint of the document recently issued by the Board of Trade regarding the new Patent Act, which comes into force on the 1st of January, 1905:—

By virtue of the provisions of the Patents, Designs and Trade Marks Acts, 1883 to 1902, the Board of Trade do hereby make the following Rules:—

SHORT TITLE.

1. These Rules may be cited as the Patents Rules, 1905.

COMMENCEMENT.

2. These Rules shall come into operation from and immediately after the 31st day of December, 1904.

INTERPRETATION.

3. In the construction of these Rules, any words herein used defined by the said Acts shall have the meanings thereby assigned to them respectively.

APPLICATIONS FOR PATENTS.

4. The statement of the invention claimed, with which a complete specification must end, shall be clear and succinct as well as separate and distinct from the body of the specification.

5. For Rule 9 of the Patents Rules, 1903, the following Rule shall be substituted:—When a specification comprises several distinct matters, they shall not be deemed to constitute one invention by reason only that they are all applicable to or may form parts of an existing machine, apparatus or process. Where a person making application for a patent has included in his specification more than one invention, the Comptroller may require or allow him to amend such application and specification and drawings or any of them so as to apply to one invention only, and the applicant may make application for a separate patent for any invention excluded by such amendment. Every such last-mentioned application may, if the Comptroller at any time so direct, bear the date of the original application, or such date between the date of the original application and the date of the application in question as the Comptroller may direct, and shall otherwise be proceeded with as a substantive application in the manner prescribed by the said Acts and by any Rules thereunder for the time being in force. Where the Comptroller has required or allowed any application, specification or drawings to be amended as aforesaid, such application shall, if the Comptroller at any time so direct, bear such date, subsequent to the original date of the application and not later than the date when the amendment was made, as the Comptroller shall consider reasonably necessary to give sufficient time for the subsequent procedure relating to such application.

PROCEDURE UNDER SEC. 1 OF THE PATENTS ACT, 1902.

6. If after the leaving of any complete specification the Examiner reports that the nature of the invention is not sufficiently disclosed and defined to enable him to make the investigation prescribed by Sub-sec 1, and the Comptroller has required amendment of the specification and drawings, or either of them, the application shall, if the Comptroller at any time so direct, bear such date, subsequent to its original date and not later than the date when the requirement is complied with, as the Comptroller may consider reasonably necessary to give sufficient time for the subsequent procedure relating to such application.

7. When the Examiner, in prosecution of the investigation prescribed by Sub-sec. 1, finds that the invention claimed in the specification under examination has been wholly claimed or described in one or more specifications within the meaning of the sub-section in question, he shall, without any further prosecution of the investigation, make a provisional report to that effect to the Comptroller. If the provisional report of the Examiner made under this Rule be not reversed or altered, it shall be deemed a final report, and the application shall be dealt with as provided by Sub-sec. 6. If, however, such provisional report be reversed or altered, the investigation prescribed by Sub-sec. 1 shall be continued, and a further report shall be made to the Comptroller, and the specification shall be dealt with as provided in Sub-sec. 5 or Sub-Sec. 6, as the case may require.

8. The time within which an applicant may leave his amended specification under Sub-sec. 2 shall be two months from the date of the letter informing him that the invention claimed has been wholly or in part claimed or described in any specification or specifications within the meaning of Sub-sec. 1. In any special case the Comptroller may, if he think fit, enlarge the time prescribed by this Rule.

9. When the applicant for a patent has been informed of the result of the investigation of the Examiner, made under the provisions of Sub-sec. 1, and the time allowed by Rule 8 for amendment of his specification has expired, the Comptroller, if he is not satisfied that no objection exists to the specification on the ground that the invention claimed therein has been wholly or in part claimed or described in a previous specification within the meaning of that sub-section, shall inform the applicant accordingly, and appoint a time for hearing him, and shall give him ten days' notice at the least of such appointment. The applicant shall as soon as possible notify the Comptroller whether or not he desires to be heard. The Comptroller shall, after hearing the applicant, or without a hearing, if the applicant has not attended a hearing appointed, or has notified that he does not desire to be heard, determine whether reference ought to be made in the applicant's specification to any, and if so, what, prior specification or specifications by way of notice to the public.

10. When under Sub-sec. 6 the Comptroller determines that a reference to a prior specification ought to be made by way of notice to the public, the form of reference shall be as follows, and shall be inserted after the claims:—Reference has been directed in pursuance of Sec. 1, Sub-sec. 6, of the Patents Act, 1902, to the following specification of Letters Patent No. ..... granted to ..... Where the reference is inserted as the result of a provisional report under Rule 7, a statement to that effect shall be added to the reference.

APPEAL.

11. Every decision of the Comptroller under the foregoing Rules shall be subject to an appeal to the Law Officer.

SEALING OF PATENT AND PAYMENT OF FEE.

12. If the applicant for a patent desires to have a patent sealed on his application, he must, on or before the last day on which a patent can lawfully be sealed, pay the prescribed sealing fee; and if such fee be not paid, no patent shall be sealed. The prescribed sealing fee should be paid by leaving at the Patent-office Form X in the Second Schedule to these Rules, duly stamped. (The Second Schedule is not reproduced.)

FEES.

13. To the fees specified in the First Schedule to the Patents Rules, 1903, shall be added the fee specified in the First Schedule hereto. (Schedule I. is not reproduced. The amount of fee is £1 for each application.)

FORMS.

14. To the Forms contained in the Second Schedule to the Patents Rules, 1903, shall be added the form X contained in the Second Schedule hereto; and in the Form C contained in the first-mentioned schedule the following direction shall be added in a marginal note, namely:—"In the preparation of the claim or claims careful attention should be paid to the terms of Rule 4 of the Patents Rules, 1905. Any unnecessary multiplicity of claims or prolixity of language should be avoided."

SIZE, &c., OF DOCUMENTS.

15. For Rule 17 of the Patents Rules, 1903, the following Rule shall be substituted:—All documents and copies of documents, except drawings, sent to or left at the Patent-office, or otherwise furnished to the Comptroller or to the Board of Trade, shall be written, typewritten, lithographed, or printed in the English language—unless otherwise directed—in large and legible characters with deep permanent ink upon strong white paper, and, except in the case of statutory declarations and affidavits, on one side only, of a size of approximately 13in. by 8in., leaving a margin of at least 1½in. on the left-hand part thereof, and the signatures thereto must be written in a large and legible hand. Duplicate documents shall at any time be left if required by the Comptroller. At the top of the first page of a specification a space of about 2in. should be left blank.

DRAWINGS ACCOMPANYING SPECIFICATIONS.

16. For Rules 18 to 24 of the Patents Rules, 1903, the following Rules shall be substituted. As the drawings are printed by a photolithographic process, the character of each original drawing must be brought as nearly as possible to a uniform standard of excellence, suited to the requirements of such process, and calculated to give the best results in the interests of inventors, of the Office, and of the public. The following requirements should, therefore, be strictly observed, as non-compliance therewith will be certain to cause delay in the progress of an application for a patent.

17. Drawings, when furnished, should accompany the provisional or complete specification to which they refer, except in the case provided for by Rule 24. No drawing or sketch such as would require the preparation for the printer of a special illustration for use in the letterpress of the specification when printed should appear in the specification itself.

18. Drawings may be made by hand or lithographed, printed, &c. They must be made on pure white, hot-pressed, rolled, or calendered strong paper of smooth surface, good quality, and medium thickness without washes or colours, in such a way as to admit of being clearly reproduced on a reduced scale by photography. Mounted drawings must not be used.

19. Drawings must be on sheets which measure 13in. from top to bottom and are either from 8in. to 8½in. or from 16in. to 16½in. wide, the narrower sheets being preferable. If there are more figures than can be shown on one of the smaller sized sheets, two or more of these sheets should be used in preference to employing the larger size. When an exceptionally large drawing is required, it should be continued on subsequent sheets. There is no limit to the number of sheets that may be sent in, but no more sheets should be employed than are necessary, and the figures should be numbered consecutively throughout and without regard to the number of sheets. The figures should not be more numerous than is absolutely necessary. They should be separated by a sufficient space to keep them distinct.

20. Drawings must be prepared in accordance with the following requirements:—(*a*) They must be executed with absolutely black ink. (*b*) Each line must be firmly and evenly drawn, sharply defined, and of the same strength throughout. (*c*) Section lines, lines for effect, and shading lines should be as few as possible, and must not be closely drawn. (*d*) Shade lines must not contrast too much in thickness with the general lines of the drawing. (*e*) Sections and shading should not be represented by solid black or washes. (*f*) They should be on a scale sufficiently large to show the invention clearly, and only so much of the apparatus, machine, &c., should appear as effects this purpose. If the scale is given, it should be drawn and not denoted by words. Reference letters and figures, and index numerals used in conjunction therewith, must be bold, distinct, and not less than one-eighth of an inch in height. The same letters should be used in different views of the same parts. Where the reference letters are shown outside the figure, they must be connected with the parts referred to by fine lines.

21. Drawings must bear the name of the applicant—and, in the case of drawings left with a complete specification after a provisional specification, the number and year of the application—in the left-hand top corner; the number of sheets of drawings sent, and the consecutive number of each sheet, in the right-hand top corner; and the signature of the applicant or his agent in the right-hand bottom corner. Neither the title of the invention nor any descriptive matter should appear on the drawings.

22. A facsimile or "true copy" of the original drawings must be filed at the same time as the original drawings, prepared strictly in accordance with the above Rules, except that it may be on tracing cloth and the reference letters and figures should be in blacklead pencil The words "original" or "true copy" must in each case be marked at the right-hand top corner, under the numbering of the sheet.

23. Drawings must be delivered at the Patent-office so as to be free from folds, breaks, or creases which would render them unsuitable for reproduction by photography.

24. If an applicant desires to adopt the drawings lodged with his provisional specification as the drawings for his complete specification, he should refer to them in the complete specification as those left with the provisional specification.

Dated the 20th day of October, 1904.

(Signed) G. W. BALFOUR,
President of the Board of Trade.

BRADFORD ENGINEERING SOCIETY.

A LECTURE was given to a large gathering of members and visitors at the City of Bradford Technical College on Wednesday evening, the 2nd inst., by Professor John Goodman, M. Inst. C.E., of the University of Leeds, on the "Use of Steel in Modern Buildings."

The President, Professor G. F. Charnock, Assoc. M. Inst. C.E., occupied the chair.

In glancing at the circumstances which had brought about the large introduction of steel into the construction of modern buildings, the author referred to the great increase in value of land in the central business portions of our great cities. When a price of £130 per square yard had to be paid for a site it was evident that the space occupied by walls and columns must be reduced to a minimum, and slides were shown contrasting the prodigality of the stone columns of the ancient Egyptian temple of Luxor with their sparse steel substitutes in the thirty-storey Chicago skyscraper of to-day. For the safe and economical design of these great complex steel buildings a high degree of scientific training was necessary. The architect and the engineer should each do their portion. The function of the various parts of a building must be carefully considered, and the material most suitable for each adopted. Just as in the human body, strong but lightly framed bones were found to exist for supporting the outer covering of flesh and to enable the individual to bear weights, so a light but strong steel skeleton was the most economical and suitable material for supporting the outer casing of bricks or tiles and the loaded floors in high buildings. The quality of steel most suitable for working into girders and stanchions was not that with the highest tensile strength. A ductile steel of about 30 tons per square inch tensile strength, and which would give an extension of about 30 per cent., was used in preference to the very much harder but less ductile tool steel, for the modulus of elasticity of the latter was very little higher than that of the soft steel. Rigidity was equally as important as strength. In the processes of construction heating of the material could not be dispensed with, but, unless carefully carried out, was a source of danger. Steel worked at a blue heat became brittle as cast iron, and should be carefully annealed. Professor Arnold had demonstrated that even if a very small percentage of sulphur was present in the steel, the particles were liable to segregate if the annealing process was too protracted, and to colonise in layers transverse to the axis of the bar, weakening the steel at this section. Hence angles and tees should be set cold if possible. Punching steel did more harm than was generally supposed; and an interesting slide was exhibited, showing the deforming effect of the punch on the steel bar. The section was shown to become coarsely crystalline, and although the tensile strength was maintained, the ductility was reduced. Generally speaking, rivets should never be put in tension, as the heads would be liably to fly off if they had been hammered up by hand at a blue heat. Unless the riveting could be done hydraulically, it was safer to use iron rivets.

Iron and steel behaved similarly under fire. Their strength increased until a temperature of about 400 deg. Fah. was reached, after which it fell away rapidly, and there was a great risk of buildings collapsing unless the iron and steel work were properly protected. Uncovered steel beams buckled in ten minutes in a fierce fire, where timber lasted two hours.

In discussing the question of live loads on the floors, the Professor remarked that the weight of the densest crowd of people, which was given in some text-books on building construction as 120 lb. per square foot, was not found by experiment to exceed 90 lb. per square foot.

After showing the various forms of steel stanchions, and remarking as to their advantages and defects, the strength of short and long columns was entered into.

In an interesting photograph of the collapse of the Campanile at Venice, which was thrown on the screen, the pyramidal fracture at 45 deg., such as occurs in short compression specimens in the testing machine, was clearly seen. A diagram showing the effect of length on mild steel struts of various sections was shown, and the effect of different methods of end holding on the buckling load was explained. Rigidly bolted ends and light counter bracing, by shortening the effective length and by preventing the initial bend when loaded, greatly strengthened a column.

The common method of bringing a load on to a column by a side bracket was shown to be most wasteful, requiring, as it did, such a great increase in sectional area of the column.

The Professor proceeded to urge the advantages to designers of constructional steelwork of plotting curves showing the cost, weight, and strength of various sections of stanchions for given lengths, and showed typical examples on the screen. The methods which were adopted by Mr. Max am Ende to withstand wind pressure in the magnificent roof of Olympia were discussed, special note being made of the round-ended columns. The character of the foundations for high steel buildings was described and illustrated. Old steel rails could be efficiently used—costing about half the price of joists—but must be cleaned of rust, or the concrete would not adhere. For the design of stiffeners in plate girders the Professor considered the ordinary Rankine rules to be wrong. If the load were evenly distributed on either the top or bottom flange, stiffeners, he said, were not required. But for concentrated loads they were, of course, necessary; and as nearly all plate girders failed when tested in the end panels, great attention should be paid to this portion of the girder. Referring to Fairbairn's experiments on plate girders, he urged the importance of internal plate stiffeners to prevent the side buckling of box girders.

Passing on to the subject of wind pressure, criticism was made of the 40 lb. per square foot given in many text-books as the stress to be allowed for. Buildings in towns were very rarely subject to a 10 lb. wind. Reference was made to Sir John Wolfe Barry's experiments on the bascules of the Tower Bridge, where the pressure was never found to exceed 5 lb. per square foot. In very exposed places inland, and also on the coast, greater pressures obtained, or accidents such as the blowing over of the train in Morecambe Bay would not have occurred. Diagrams were thrown on the screen showing the effect on buildings with roofs of different pitches of the effect of wind pressure on the one side, and "suction" on the leeward side, and the various methods of diagonal bracing or gussets for resisting the stress. The acceleration and retardation of the modern high-speed travelling crane in workshops necessitated special bracing between the stanchions to prevent longitudinal oscillation.

In designing structures it must be remembered that the lightest sections which were theoretically required were not always the cheapest. Standard sections should be specified, as the cost of rolling special sections was great unless a very large order was given. It was cheaper to group one's sections, say, in designing a lattice girder, and use a comparatively small number of different sizes, although the weight might come out a little greater. The expense of erecting one's design must not be forgotten, as labour was more costly than material. In conclusion, the lecturer referred to the greater sound conductivity of steel-framed buildings as compared with the ordinary timber and masonry structures, and recommended that joists and columns should be bedded on cocoanut matting if sound proofness were to be desired.

The discussion was opened by the President, who alluded to the system of reinforced concrete which was now in being, and said he would like to see some local factories or warehouses built on this plan. Mr. James Ledingham, F.R.I.B.A., said that the earliest habitations known were of timber; later of mud; then baked mud. The stone age followed, and now we had reached the iron or steel age.

Mr. A. D. Ellis, M.I. Mech. E., pleaded for a discrimination between the utilitarian and the artistic, and criticised the false effect of the masonry casings of the Tower Bridge.

Mr. James Watson, M. Inst. C.E., advised the young members in designing their structures to use the materials nearest at hand in the best possible way, and to keep the factor of safety high. He alluded to the fallacious nature of some tests of cast iron, and how calculations as to strength of this metal could be upset by the effect of a frosty morning, or a shower of rain on the casting as it cooled.

The discussion was continued by Mr. F. E. P. Edwards, A.R.I.B.A., and Messrs Hiles and Parkinson, and the meeting closed with a hearty vote of thanks to Professor Goodman for his lecture.

On the 16th inst. a paper was read by Mr. Herbert W. Morley, M.I. Mech. E., on "The Commercial Aspects of Power Plants in Factories." There was a large attendance, and the chair was taken by Mr. Robert Hiles.

The lecturer dealt with the usual methods of generating power, and made special reference to its economic production and distribution in the textile factories in this district. In discussing the question of site he noticed briefly the cost of the transport of materials, the importance of the water supply for power and industrial purposes, the proximity of the workpeople, the question of assessment and rates, and the position of the engine and boiler-house. He discussed the influence of the turnover of the local manufacturers on the engine practice of the neighbourhood as compared with Germany. The relative merits of the horizontal and vertical engines having regard not only to the first cost, but to annual expense were then dealt with. Mr. Morley considered that gas engines were not sufficiently reliable and cheap for factories at the present time. Proceeding to the subject of transmission, the lecturer considered that electrical transmission was more costly and less efficient for textile factories than shafting, and he described the various methods of rope and belt drives. Examples were given of frictional losses which obtained in shafting, and diagrams were shown giving the steam consumption of various engines and the influence of superheating on economy. He showed to what extent these frictional losses of the engine and shafting affected the annual coal bill; and entering into the question of interest on capital and sinking fund for depreciation, he showed what expenditure might economically be laid out to reduce the annual working expenses. In conclusion, the lecturer contrasted the average rental per spindle which could be obtained for room and power in the case of a 20,000-spindle worsted mill, with the annual cost of producing the power per spindle—including

coal, stores, wages, depreciation, interest, repairs, &c.—first, with a modern economic steam plant costing £7000; and, secondly, with an old type beam engine valued at £3300.

In the discussion which followed, Mr. H. A. Jones spoke of the advantages of electrical driving, and referred to the growing popularity of polyphase motors in Italy and Germany. Mr. Seton also contributed to the discussion, speaking of the advantages of superheating, and the President—Professor Charnock—in moving a vote of thanks, which was subsequently carried unanimously, remarked that such a valuable paper, along with the correspondence which would be sure to ensue if it were published by the Society, should certainly be printed for circulation amongst the members.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

PUMPING ENGINES.

SIR,—In your issue of the 4th inst. you state, in a leading article, that, "Taken a whole, it is certain that the United States pumping engines are the most economical of fuel in the world." The figures you quote in support of your argument show that a triple-expansion engine with saturated steam at a pressure of 121 lb. worked at the rate of 11·68 lb. of steam per indicated horse-power hour. This is no doubt an excellent duty, but considering that this is an engine of 574 horse-power, we fail to see that the performance is materially better than that of an engine built by us for the Leeds Corporation, which was tested by Professor Unwin, and described in your issue of February 9th, 1900, and which, with a steam pressure of 136 lb., and with an output of only 168 actual horse-power, required 11·91 lb. of steam per indicated horse-power hour, and of which he remarks in his report, "This is almost as high a duty as has ever been recorded." The duty of this engine, measured in water raised, was 138,600,000 foot-pounds per million B.T.U., and the thermal efficiency 19·53 per cent.

Another Leeds-made engine, particulars of the test of which have been published, when tested by the Odessa Municipality, gave similar results. This engine required, according to the official report, 11·35 lb. of steam per indicated horse-power hour. This is actually a better duty than that to which you refer, but it should be noted that there were 5 deg. Fah. of superheat in the steam at the engine stop valve. The duty of this engine in measured water raised was 144,000,000 foot-pounds per million B.T.U., and the thermal efficiency 20·3 per cent.

But it was your remarks as to the duty obtained from the quadruple-expansion Nordberg engine which more particularly attracted our attention. After stating that the duty expressed in foot-pounds—we presume, measured in water lifted—per million B.T.U. is the highest recorded, you go on to say that the engine required only 186 B.T.U. per indicated horse-power per hour—we presume that this is a misprint for per minute—and this, although the steam used amounted to 12·26 lb. at 200 lb. pressure per indicated horse-power hour.

We have not seen the report of the trial of this engine; but from the above figures it would appear that the feed-water must have left the engine at a temperature of somewhere about 322 deg. Fah. This high temperature suggests the question as to how far the 15 per cent. of the total steam used, which you refer to as having been consumed in heating the feed-water, came to be adequate for the purpose. *Prima facie*, it appears that the thermal units given to the feed-water in its passage through the various heaters exceeded those available in the above 15 per cent., and that there must, therefore, have been some other source of heat. No doubt, however, this difficulty would disappear with the more detailed information which you have before you. But a more important point remains. A feed-water temperature of 322 deg. Fah. corresponds to a pressure of about 90 lb. absolute, which must have considerably complicated the problem of draining from the cylinders and receivers the largely augmented quantity of condensed steam to which you refer, without loss of heat, so that it does not seem surprising that—as you mention in your article—no more engines have been built in this manner "because the system apparently involved so much complication as to bar its general introduction." But if so, we submit that it is rather a large scale laboratory experiment than a fair comparison with actual practice, and that the somewhat sweeping conclusion which you draw as to the superiority of American to English pumping engines in point of economy is hardly justified.

HATHORN, DAVEY AND CO.

Sun Foundry, Leeds, November 22nd.

[The figures we have given are those of Mr. Reynolds, given in his paper read at the Engineering Conference at St. Louis; they are not ours.—ED. THE E.]

DRY AIR IN THE BLAST FURNACE.

SIR,—I have been interested in your leading article on the above subject, but am much surprised that you should consider it a new idea, as I have been doing this class of work for nearly twenty years. Now that an American has spoken on the matter, no doubt Englishmen will take it up, for it seems to me that it is only for an American or German to make a public speech, and the English can hear and understand, but one of their own countrymen may cry in the wilderness for twenty years without being countenanced. I have always used cold water as my medium, for when I have suggested the refrigerator I have been ruled out of court on account of cost, but even with cold water I can extract 40 per cent. of the moisture in the air, at normal temperatures, and add 5 per cent. of oxygen to the cubic foot, and the cost of my installation is a mere bagatelle. The normal atmosphere on a warm summer's day in the shade at 80 deg. Fah., and containing 90 per cent. of moisture, 9·8 grains to the cubic foot, reduced to 60 deg. Fah. and at saturation, containing 5·8 grains to the cubic foot, gives a result of 40 per cent. decrease in moisture.

I do not agree with your remarks on the effect of moisture in the furnace. You say that the heat expended in dissociation of the H_2O not far from the tuyeres would be given back by the H_2O combining further up in the furnace. Truly, but this is only the undoing and the doing, and is no use to the furnace, whereas if the H_2O had not been present this heat expended would have prepared the carbon in the coke for combination with the oxygen of the blast and completed the combustion in the formation of CO_2 instead of some CO; the heat of 1 lb. of the former being 13,000 units, and of the latter 4000 only. I calculate that 11 per cent. of the gain is thus accounted for, and 9 per cent. by the extra oxygen admitted to the furnace through contraction caused by the lower temperature. Based on the figures stated in the paper, the reduction in moisture is 70 per cent., and the increase in oxygen 9 per cent.—but at what a gigantic expense! With cold water, and at a very small cost, I can decrease the moisture 40 per cent. and add 5 per cent. of oxygen.

Some few years ago I did a very interesting job. One of our large newspaper proprietors wanted to start some kind of colour work, and employed German artists, who insisted that the work had always been done in Berlin, and could not be done in England on account of the damp atmosphere. I was sent for, and applied my system to the place, and have the pleasure of knowing that by making the Berlin atmosphere I created a new business for my own country. I may also state that after twenty years my machines are as much alive as ever. I am doing a job at the present time for a firm employing 3000 workpeople. I finished a job last week, and another six weeks ago. Finally, I have taken out fifteen patents, good, bad, and indifferent, dealing with air and water, but I am heart sick and weary of the work, for in my experience people want "everything for nothing," unless it be American or German.

PHILIP PARSONS.

Blackburn, November 21st.

H.M.S. TERRIBLE.

SIR,—Recently published figures cause much perplexity. It would appear that in 1902 the coal used for domestic purposes, such as cooking and warming in stoves, was 24·6 tons a day for sea and harbour work. In 1904, the outward voyage, this was 12·75 tons a day, and on the homeward voyage 10·3 tons a day.

In addition to this, for harbour auxiliary purposes, such as lighting the ship, pumping of water, &c., in 1902 the consumption was 93·2 tons a day; in 1904, 25·7 tons a day on the outward voyage, and 6·44 tons a day on the homeward voyage.

However economical boilers and engines in 1904 had become, there is the fact that in 1902 the total amount of coal used for auxiliary purposes and distilling was less than in 1904 while at sea, and this in spite of the fact that the distilling was not so economically done; a ton of coal in 1902 giving 6·915 tons of water, and 1904, 8·082 tons. The consumption of water slightly decreased per hour, which may be explained by the less indicated horse-power, being 1·196 tons per hour at sea in 1902, and 1·688 per hour at sea in 1904. This probably includes water for drinking.

The figures seem to show that with a deeper vessel and longer out of dry dock it takes less horse-power to drive her than when light and apparently recently docked. But, as time out of dock is not always the gauge of the state of the bottom, possibly the 1902 voyage was performed after some time lying in semi-tropical water, and possibly with different wind during the voyage.

It would have been more interesting had the number of revolutions been given for the total voyage, but no doubt the whole business is a pointer as to how Belleville boilers are to be repaired, and in what direction economy is to be effected, such as by more efficient clothing of hot surfaces, and different working of auxiliary machinery.

The following table is an analysis of the figures published:—

	1904. Outward voyage.	1904. Homeward voyage.	1902. Homeward voyage.
Total distance steamed, knots	10,645·5	11,095·6	11,045·8
Mean indicated horse-power	4330	5054	5738
Average speed, knots	12·4	12·8	11·8
Hours on the way	858·5	866·8	936·1
Square feet of grate used	769·4	787·9	1113·2
Coal per hour per square foot of grate, lb.	13·4	14·7	17·3
Coal—			
For main engines, tons	3043	3391	7086
Auxiliary engines at sea, tons	733	926	704
Distilling at sea, tons	193·8	165	258
Culinary purposes at sea, tons	458·2	371	959
Culinary purposes in harbour, tons	254·6	144·2	292
Auxiliary purposes in harbour, tons	322·4	89·8	1864
Totals, tons	5005	5087	11,163
Days at sea, approx.	36	36	39
Days in harbour, approx.	20	14	20
Mean draughts on voyages	28ft.	26ft. 5½in.	26ft. 7in.
Coal for main engines ÷ coal for auxiliary engines	4·15	3·66	10·06

November 22nd.

PERPLEXED.

THE EFFICIENCY OF A SUCTION GAS PLANT.

SIR,—We think the enclosed particulars of a test of one of our suction gas plants, specially designed for working on common gas coke, would be of interest to your readers.

Engine started with compressed air with pressure in reservoir 100 lb. per square inch. Coke used obtained from Manchester Corporation Gasworks; sample analysed consisted of following:—Ash, 15·60 per cent; moisture, 1·30 per cent.; volatile matter, 1·80 per cent.; fixed carbon, 81·30 per cent.; having a calorific value of B.T.U. per lb., 12,411; calories per K.G., 6896.

Dynamo ran sparklessly at all loads with fixed brushes, and perfectly cool. Efficiency obtained from tests at Chelmsford, 91·75 per cent. Electrical readings taken were 1 per cent. low; the instruments after test being calibrated with standards at the Manchester Technical School. After test, valves and sparking plug examined and found in good condition, no excess water present in gas pipes, expansion box, or pockets.

To ensure complete accuracy with regard to the measuring of the fuel after the test run, the ashes and clinker were removed from the lower portion of the producer and the fire was made good again to a predetermined level at which the start was commenced. The actual time of the full load test was six hours, but the producer was working twenty minutes before this to get the fire in good condition for starting for the full load, and the fuel so burnt was not deducted from the total consumption, so that the results given below would have been slightly better if any arrangement had been made to measure the amount of such coal burnt before the commencement of the full load test.

Summary.

Total fuel consumed	488 lb.
Total K.W. hours	363·4 (corrected).
Fuel per hour	81·3 lb.
K.W. per hour	61·4
Fuel per K.W. hour	1·325

This is equal to ·92 lb. per brake horse-power hour.

This plant was made for the Howrah station of the Calcutta Electric Supply Corporation, Limited, for use in conjunction with one of our "Y E" type high-speed gas engines driving a dynamo. The test was taken by the representatives of Messrs. Crompton and Co., Limited, of London and Chelmsford, consulting engineers and contractors, on Wednesday, September 7th, 1904.

CROSSLEY BROTHERS, LIMITED.

Manchester, November 22nd.

THE REACTION IN A DIVERGING NOZZLE.

SIR,—"Testor" asks for information as to how to calculate the thrust due to reaction when steam flows out of a backwardly-moving diverging nozzle. There seems to me to be no difficulty about this, if the velocity of the steam leaving the nozzle and the amount of steam discharged per second be known.

Let V = mean velocity of steam leaving nozzle relatively to nozzle.

Let v = mean velocity of steam entering nozzle relatively to nozzle.

Let m = mass of steam passing through nozzle per second.

Then change of momentum of steam in nozzle per second $= m(V - v)$ ∴ Force exerted on nozzle $= m(V - v)$.

This equation is unaffected by any velocity which the nozzle may have.

R. M. NEILSON.

30, Cross-street, Manchester,
November 19th.

AIR EJECTORS.

SIR,—I should feel obliged if any of your readers could inform me as to how to get the best results out of an ejector which is used to create a vacuum of an inch of water, and to draw as large a volume of air out of the vacuum chamber as possible.

The ejector consists of an internal air tube 1¾in. diameter, surrounded by an annular space 2¼in. mean diameter, and which can be varied in thickness from zero to ¼in. by moving the inner tube, which is conical on the point. There is also an outer air space surrounding the ejector ring, which is 3¼in. in diameter.

An air pressure of 40 lb. per square inch is obtained in the annular space, the stream issuing from which draws the outer and inner volumes of air into a tapering funnel about 5ft. long.

The question which is to be determined is the proper opening of the annular space, and, owing to circumstances, it is very difficult experimenting, the whole apparatus having to be taken down to alter the spacing.

INQUIRER.

Coatbridge, November 22nd.

THE ADHESION OF STEAM WAGON WHEELS.

SIR,—About fifteen months ago we purchased a steam wagon from a firm having a first-class reputation, and we informed them that if the wagon was satisfactory as to general running, and would keep the roads in snowy weather, we were prepared to purchase four or five more.

Last winter, when there was at most 2in. to 3in. of snow, the wagon remained at home, as she was practically helpless unless nursed with sand, ashes, and bagging, or chains lashed round the wheels.

To-day, when there was about the same amount of snow, the wagon was the centre of observation, and the object of ridicule of about sixty wagoners, as it took nearly an hour to travel on granite setts about 500ft. on fairly level ground in our own yard.

We then put on steel wheels with smooth peripheries, the same as the others, but wider, and with a load of two tons, five miles were covered in five hours and a-half, so that as long as this weather lasts the wagon will have to remain over the pit, as the racing of the wheels renders us liable to an engine smash.

The makers seem to be practically indifferent as to whether the wagon is weather-bound or not, and, as they are people of wide experience, we can only arrive at the conclusion that they do not know of any wheels that will enable the wagon to traverse loose snow or hard frost and slippery ground. To-day, after a little extra work upon the part of our farriers, the vehicular traffic went on much the same as usual, while the powerful and expensive steam wagon remains idle.

I should like to hear the opinions of other users of steam vehicles in the provinces, especially in country districts.

ALP.

Wolverhampton, November 22nd.

VALVES AND VALVE GEAR.

SIR,—We have read with much interest your leading article in your issue of the 18th November last on valves and valve gear.

As manufacturers for many years of engines with drop valves, we can thoroughly endorse your favourable opinion of them. We may, however, be permitted to call your attention to the statement "that engines fitted with it cannot be run comfortably at a speed of more than about 90 revolutions per minute," as for some years we have had engines fitted with drop valves and trip gear working at 150 revolutions per minute with every satisfaction. These engines are not only most silent in their action, but give, we believe, a very high economy.

(FOR ROBEY AND CO., LIMITED)
W. T. BELL, Secretary.

Lincoln, November 22nd.

DOCKYARD NOTES.

WE have often in these Notes raised the question of funnel hits in warships and the probable consequences of shell bursting in funnels. The general impression was, first, that shell would go clean through the funnel before bursting; secondly, that, if by any chance they did burst inside, all the fires below would be put out. This general impression seems to have been quite inaccurate, for it is now known that the Tsarevitch was hit twice in the after funnel and once in the forward one by 12in. shell. All three burst inside, and no pieces went forward. The first two hits did no harm at all below; the second hit in the after funnel destroyed the economiser tubes of one boiler group and did no further harm. With wrecked funnels and a hole in her side below the water-line, the Tsarevitch steamed away from the battle at at least 14 knots speed.

IT is now conclusively proved that she was very little injured. She lost but eight men killed and fifty wounded, and she had but one gun—a 6in.—disabled. She might, unless short of coal, have continued fighting indefinitely, and the defeat of the Russians in the battle of Round Island can only be attributed to the absence of "grit" on their part. Indeed, they seem to have inflicted more harm than they received, for the Mikasa lost 120 men—double what the Tsarevitch lost—and the much criticised inability of the Japanese to follow up their victory is now to be explained by the fact that there was no "victory" for them. The Russians were almost victors when, for some still inexplicable reason, they turned and ran away. Hence their defeat; and few will be found to say that they did not deserve it.

THE whole of the Aurora class, the Imperieuse and Warspite, the five Medeas, and probably all the ships of the Pallas class, are to go to the scrap heap or harbour service. Many of the Apollo class are likely to follow soon, and possibly enough the Admiral class also. This is the first touch of Admiral Fisher, and it is one which will earn for him the gratitude of all believers in naval efficiency.

PORTUGAL is "going to" increase her navy. A Commission is visiting Germany and the United States with this object.

RUSSIA has ordered eleven destroyers in France and ten in Germany for delivery in September, 1905, should the war be over by then. It is stated that a further order for ten boats was to have been placed in this country; but owing to the Baltic Fleet incident it is at present held over. We cannot say how much truth there is in the report.

THE new cruisers of the Minotaur class will be built without rams. The French have done this with cruisers for some years.

FRENCH FOUNDRY PRACTICE.—At a recent meeting of the Leeds University Engineering Society, Mr. G. H. Attock brought forward the subject of "French Foundry Practice." He stated that while English foundry masters more than held their own with regard to heavy castings, France and Germany excel in the production of small or intricate castings. This is especially noticeable in work for the motor car and motor cycle trades. The predominance is, he thought, due to the extensive and intelligent use of moulding machines in foreign foundries. He had seen in France twice as many pieces turned out per hour from a moulding machine, worked by a labourer, as an English moulder could turn out per day. This superiority is entirely to the credit of the machine, as the average English moulder is a better worker than the average French moulder. Mr. Attock exhibited lantern slides of the possibilities of these machines, and stated that they were gaining favour in England.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE more kindly aspect which the iron and steel trades of this district were beginning to put on, has been assisted this week by the sudden appearance of winter. It has strengthened the coal market and has suggested to pig iron consumers the possibility, if the frost holds, of a shortness of supplies from the furnaces. The stronger rates spoken of last week for raw iron are this week more than confirmed. On 'Change in Birmingham this—Thursday—afternoon, sellers were in command of the market. They declined to book forward contracts with the readiness of a fortnight or even a week ago. For early delivery, too, prices were stiffer. The continued import in the American iron and steel trades is regarded on this Exchange as one of the best signs for the forthcoming year. The latest reports from the other side of the Atlantic received in this district state positively that activity has arrived in American iron, and the belief in continued prosperity is the dominant note in American iron and steel circles.

A few of the iron and steel men who have been to the United States with the Iron and Steel Institute were present on 'Change this afternoon. More will be present this week. The views of these manufacturers are being actively canvassed concerning whether the American improvement will develop into a boom or will be only temporary. It is admitted, in some of the best informed directions, that the indications are that the better things will be lasting, *i.e.*, at least of a sensible duration. It is reported by the returned Midland ironmasters that the American market for iron is strong, especially for pig iron, and that even the fewer furnaces still idle are expected soon to be blowing again. The Steel Corporation of America has recently stated that the daily average of new business is 26,000 tons, or 30 per cent. over last year, which, it will be remembered, was a bad one. What an American iron and steel revival, if well founded and at all prolonged, means for the Birmingham and Staffordshire iron and steel making districts need not be enlarged here. Former experiences of transatlantic revivals and of corresponding benefits on this side will occur to the mind of every iron and steel man.

Pig iron again led the market this afternoon. It was in this department that most improvement showed. Sellers were distinctly on the top. Sales have of late increased a little in number and weight, and salesmen are making the most of the position. The possible scarcity in fuel, should winter conditions continue, and a corresponding shortness of pig iron supplies, was also a factor not overlooked by middlemen this afternoon. Staffordshire forge pigs were quoted 42s., and part mines 43s. to 45s. All mines were 55s to 60s. per ton, best ditto, 75s. to 80s., and cold blast iron, 95s. to 100s. per ton. Imported pig iron changed hands on the following bases:—Northampton, grey forge, 41s. to 42s., firm; Derbyshires, 43s. to 44s.; North Staffordshires, 43s. 6d. to 44s. 6d.; and Lincolns, 48s. 1d. per ton.

No decline is observable in the better demand for certain sections of the products of the mills and forges. Black and galvanised sheets are both in distinctly better sale. Prices, too, are better. Makers of black sheets quote with firmness £6 15s. to £6 17s. 6d. for doubles; while galvanised corrugated sheets are firm at £10 10s. to £10 15s. f.o.b. Spelter is still rising, and seems likely to do so. Bar iron is quoted £8 for best, £7 for merchant qualities, and £5 15s. to £6 for common. North Staffordshire bars are £6 5s. to £6 10s.; South Staffordshire angles are £6 to £6 5s.; and hoops, £6 12s. 6d. to £6 15s.

The steel trade is healthier. Continental competition has for the moment almost stopped, and local works are doing better. This is so alike as to demand and price.

Coal occupies a stronger position owing to the severe weather, but no new price lists are yet advised.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—There was a better feeling on 'Change on Tuesday, in the engineering department; and now that full time is being worked in the cotton districts, there is every prospect of good trade for some time forward. A disposition is manifested to renew machinery, and bring it up to date. Some fair orders are also reported as having been received from abroad for textile machinery. The absence of serious competition from German and American quarters is also a factor in that revival of trade which has been anxiously looked forward to for many months past, and which now seems fairly to have set in. There is also some improvement in the position of the industrial engineering trades, and it is to be hoped that this will continue. There is every inducement for buyers to operate, as it is felt that prices had reached their lowest, and, although some consumers have covered their requirements for some months to come, there are others who have only bought from "hand to mouth," and are now compelled to purchase at the higher figures now demanded. The increasing business in Middlesbrough warrants and the advanced rates quoted in Glasgow had the effect here of putting up prices fully 1s. per ton for all classes of pig iron. Some merchants complained, however, that they cannot get buyers in some instances to take delivery under contract. Lincolnshire makers did not declare any official advance, but holders asked 1s. per ton more money, while Lancashire during the past fortnight or three weeks has advanced 1s. to 1s. 6d. per ton for foundry iron. Derbyshire and Staffordshire is also fully 1s. dearer.

Last year, it will be remembered, American pig iron could be bought on the basis of about 50s. c.i.f. Manchester, and 48s. 6d. c.i.f. Liverpool, but now the tables are turned, and another dollar per ton of an advance on the other side would probably result in shipments of English pig iron to "the other side." It was openly stated on 'Change that the reported advances in Middlesbrough for the past three weeks or so have been caused by purchasers on American account. Stocks do not show much increase. Quotations delivered Manchester prompt are as follows:—Lancashire, No. 3 foundry, 51s. 6d. to 52s.; Lincolnshire, 48s. to 48s. 6d.; Derbyshire, 50s. 9d. to 52s.; Staffordshire, 50s.; Middlesbrough, open brands, 53s. 6d. to 54s. Scotch: Gartsherrie, 55s. 9d. to 56s. 6d.; Glengarnock, 54s. to 54s. 3d.; Eglinton, 53s. to 53s. 6d. Ditto, delivered Heysham prompt, No. 3 Eglinton, 50s. 6d.; Glengarnock, 54s. to 54s. 3d. No. 3 Middlesbrough is quoted 46s. 3d. f.o.t., and Barrow hematite 54s. 9d. f.o.t. For forward delivery 3d. more is asked, f.o.t. Middlesbrough, but Barrow hematite is unchanged. For forward delivery at Manchester No. 3 Dalmellington is quoted 52s. 6d. to 53s.; Glengarnock, 54s. to 54s. 6d.; Eglinton, 53s. 3d. to 53s. 9d.; Gartsherrie, 56s. to 56s. 6d. For forward delivery Heysham, No. 3 Dalmellington, 50s. 3d to 50s. 6d.; Eglinton, 51s. to 51s. 6d.; Glengarnock, 52s. to 52s. 6d.; and Gartsherrie, 53s. 9d. to 54s. 3d. Forge iron does not participate as yet to any great extent in the improvement noted in foundry iron. Forges are still quiet, and the demand is far from good. There were, however, some inquiries on 'Change on Tuesday for delivery Warrington, and buyers were apparently more inclined to operate. Lancashire forge may be quoted 48s. 9d. to 49s.; Derbyshire forge, 45s. 6d. to 45s. 9d.; and Lincolnshire forge, 46s. 6d. to 46s. 9d.

Finished iron has been a shade better, and more inquiry is reported. Prices of Lancashire and Yorkshire bars do not vary materially, and North Staffordshire are fairly firm. The Scottish advance in bars and angles of 2s. 6d. and 5s. respectively is not likely to be followed here. Lancashire and Yorkshire bars, £6 2s 6d. to £6 5s.; Staffordshire bars, £6 5s. to £6 7s 6d.; hoops, £6 17s. 6d.; sheets, £7 5s. to £7 10s. In constructional steel there has been a fairly steady inquiry. There are also a good number of inquiries in other departments, and steel bars are firm at £6 to £6 2s. 6d.; English billets steady at £4 7s. 6d. to £4 12s. 6d.; German, £4 to £4 3s; hoops, £7 5s., delivered Manchester. Boiler plates are in rather smaller demand on the Association basis of £6 17s. 6d. Raw copper has also been held for full rates. The increase in the price of copper has checked the inquiry for the manufactured article. Copper sheets are held for £80 to £82; seamless copper tubes, 10d.; copper wire, 9d.; brass tubes, 8d.; rolled brass, 7¼d.; brass wire, 7¼d.

There was a good demand attendance on the Coal Exchange, and in view of the sudden spell of wintry weather there was some discussion as to forward prospects. Stocks, however, are fairly good, and this will prevent any increase in price unless the present condition of things remains for two or three weeks longer. There is undoubtedly a better demand for house coal, and engine slack continues in strong demand, owing to the full time being worked in the cotton trade. Forge and manufacturing coal continues quiet, but in the shipping department a better feeling is reported, especially for forward delivery. Quotations are as follows:—Best coal for domestic purposes, 13s. to 14s.; seconds, 12s. to 13s.; common, 9s. to 10s.; best engine slack, 7s. 6d. to 8s.; medium, 6s. to 6s. 9d.; common, 4s. 3d. to 5s.; steam aad forge coal, 8s. 3d. to 8s. 9d.; screened coal delivered Manchester Ship Canal, 9s. 3d. to 9s. 9d.; unscreened, 8s. 9d. to 9s. 2d.

Notice has been given by the Lancashire employers to the Boilermakers' Society of a reduction of 2s. per week on the standard rate of wages, and 5 per cent. reduction on piece work. It will come into operation about the middle of February.

Barrow.—There is a stronger demand for hematite pig iron, and makers have lately been doing a fuller business. The demand is slowly gaining strength. Makers are not well sold forward, but they are better off for orders generally than they havs been for some time, and the inquiry is not only for prompt, but forward deliveries. At length prices have moved upwards. Mixed Bessemer numbers are at 54s. net, f.o.b., and some makers ask 55s., while warrant iron is at 54s. 9d. net cash sellers, buyers 6d. less. Stocks in the hands of makers have been reduced to a point which is of no importance, and which are not calculated to have any effect on the rise and fall of the market. Warrant iron remains steady, with only 12,392 tons in stock. There have been no operations during the week, and holders are very firm. Business in lower grades of iron is very small, but there is a good demand for charcoal iron. The Carnforth Iron Company have put another furnace in blast this week.

In iron ore the business doing is very quiet, but a more liberal demand is expected, as an additional output of pig iron is being arranged for, and this is likely to lead to a fuller use of native ores, although a fair tonnage of Spanish ore is being imported at Furness and West Cumberland ports. Prices are steady at 8s. 6d. for good average qualities of native ore, net at mines.

There is more activity in the steel rail trade, and the mills at Barrow and in West Cumberland are now working full time. They have been very indifferently employed for some months past. More regularity of demand and output is expected under the auspices of the new international steel ring, and certainly the immediate demand is better, while new orders are in the market, and likely soon to be placed as well on home as on foreign account; 80s. is about the price per ton for heavy rail sections. Light rails are quiet, but a few orders are offering for tram sections. Shipbuilding material is in very quiet demand, and orders in the market are few in number and small in extent. Other branches of the steel trade are quiet.

Shipbuilders are very quiet, and the trade is very unsettled, as local yards are on the point of what promises to be a serious trade dispute. The masters want a 5 per cent. reduction on piecework and 1s. 6d. per week on time men, and the men are opposing it. The decision will be made known in a few days. The new submarine B1 has had a very successful trial outside of Barrow Harbour. She was under water three hours, and rose again two miles from the point where she sank in the first instance.

Shipping is quiet. Last week's exports were 13,375 tons from West Coast ports, including 6045 tons of pig iron and 7330 tons of steel. In the corresponding week of last year the exports were 11,165 tons, showing an increase of 2210 tons. Total for the year, 653,374; corresponding period of last year, 788,856 tons; decrease, 135,482 tons. Freights remain very low.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

WINTER is now fairly upon us. It came suddenly in the night, with a sharp cold touch, succeeded by a white world next morning. The result has been to cause householders to set about completing their winter supplies of coal, and the increase in price decided upon as far back as September is certain to be obtained now. The moderate tonnage reported last week for London and the Eastern Counties, with the feeble local demand, has now changed to something like winter activity in many quarters. In best Silkstones the weight available for the market is but limited, and 12s. per ton is readily obtainable, with secondary sorts about 1s. per ton less. Barnsley house, in which the largest business is done, is at 10s. to 10s. 6d. per ton, with every prospect of going higher; secondary sorts can be had from 8s. 6d. to 9s. per ton.

Steam coal, having regard to the shipping season being about over, continues fairly satisfactory. Hull and Grimsby are both receiving considerable tonnages, the demands of the steam fishing trawlers belonging to the ports being now an important factor in the trade. The railway companies are also taking heavy deliveries under contract, at from 8s. to 8s. 3d. per ton at the pits in owners' wagons.

Gas coal, as is usual at this season of the year, is in active request, large tonnages being forwarded to the corporation gas departments and gas companies. Prices are generally about 6d. to 9d. per ton less than those contracted for last year. The gas companies, through the continued clear, mild weather, have, up to the beginning of this week, not required such heavy deliveries as they used to do.

Small coal is again a little more actively called for, the chief demand being for good slack and nuts. The continued unsatisfactory state of the coke trade, however, causes coking slack and smudge to be in very feeble demand. The make of coke is chiefly confined to collieries which have their own ovens. Although the tonnage forwarded to North Lincolnshire and Derbyshire is stated to be rather better, the improvement cannot be said to have made any difference to makers.

In the iron and steel trades a little more confidence is expressed. The volume of business is fairly good, but the prices remain unsatisfactory. Any change, however, is expected to be in an upward direction. The Parkgate Iron and Steel Company, Limited, expect their new blast furnaces to be shortly brought into use. The capacity of the new converters is expected to greatly exceed that of the old furnaces, and they will also secure valuable advantages in working.

The prices for hematites—West Coast and East Coast—Lincolnshire foundry and forge iron, and for bars, remain as quoted last week.

Of all the heavy industries the engineering departments are probably the most in need of work. In railway and marine material there is much less doing than was expected would be the case towards the end of the year, but there is confidence expressed that new work on railway account for several home companies is certain to be placed ere long. A few Indian and colonial orders are keenly competed for. A fair amount of employment is being found in the tramway and light railway material departments, but a good deal more could be done, and fresh orders are looked for.

With the close of the Presidential election, the United States trade is expected to get better, although business has been less affected by this election than in former years. The reason, no doubt, is that the tariff did not come to the front during the struggle. The Americans continue to order the highest-class cutlery, supplying themselves with the secondary grades, which, however, constitute the bulk of the business. Still, the principal houses doing an American trade state that recent orders for best goods exceed what was done at the corresponding period last year. There are also more encouraging accounts from Australia and South Africa.

The season orders in silver and plated goods are being completed, and the trade has been a fairly good one—better, indeed, than was at one time anticipated. The work, as usual, has been most unevenly divided, certain establishments running full time, and finding it difficult even then to get their orders off in time, while other firms cannot give their men the ordinary working hours. All round, however, there is less to complain of than was the case at the corresponding period of last year.

The Lord Mayor of Sheffield, having been requested to open a relief fund in aid of the distress caused through lack of employment, has made inquiries at various public departments, the Boards of Guardians, and in other authoritative quarters, with the result that, "after a full review of the circumstances that now exist in Sheffield," his lordship is of opinion that at present there is no necessity for taking the step suggested. The Lord Mayor's decision is generally approved. Although there is considerable want, the condition of affairs is not beyond the existing machinery to meet, and should the distress extend the Lord Mayor will promptly take any measures necessary to cope with it. In a speech last Friday the Lord Mayor expressed the opinion that it might be necessary to start a relief fund, but said that as it was the same people who always gave the money by subscription it might be well to try a voluntary rate, so as to get the money more equally from all the citizens.

NORTH OF ENGLAND.

(From our own Correspondent.)

THE operations of the speculators in Cleveland warrants and the fluctuations in the prices consequent thereon are the predominating features of the iron and steel market again this week, but it must be reported also that this business is supplemented by the buying of consumers, who have purchased more freely during the last few days than for more than a month. London houses are still the most prominent operators, and it is evidently the opinion of those joining in the "gamble" that there is still something to be made out of pig iron warrants. As high a price as 46s. 7d. cash has been offered and paid by buyers for Cleveland warrants. That is 4s. per ton above the figure that ruled when the upward movement in warrants commenced in July, and is 5s. above the minimum of this year. The greater part of the advance that has taken place during the last two months has been induced by speculation, for there can be no question that nothing in the condition or prospects of trade has justified any such rise. The market here is strengthened by the encouraging reports from the United States, where the output of pig iron has been increased lately, and yet stocks decrease, and prices improve; that has a good deal of influence on this side. Cleveland makers receive inquiries from consumers in the States, but these do not lead to business, the prices here being too high to admit of it.

The speculators have to confine their operations to Cleveland warrants, for they are the only warrants of which there is any considerable stock, and in which, therefore, they can deal with comparative safety. Of Middlesbrough hematite iron there are only 300 tons in the public warrant stores; of Cumberland hematite 12,392 tons; and of Scotch iron 9514 tons, quantities far too small to allow of their being made counters for the gamblers. It is otherwise with Cleveland warrants, of which there is a stock of 142,041 tons, and the stock is being added to rapidly; in fact, this month there has been an increase of 27,013 tons, and since July 64,028 tons have been added. Besides this, it is to be expected that the stock will continue to increase, as makers themselves have sold warrants freely, as they could get so much better a price for them than for No. 3 sent direct from their own yards. They will thus have to send considerable quantities of their iron into Connals to make these warrants. It is not improbable that after the gamble is over the large stock of Cleveland pig iron in the public warrant stores will weaken the market, but at present the increase has not any influence that is detrimental to the trade.

It may also be reported that the unsatisfactory shipments of pig iron from the Cleveland district are practically ignored. This month they have been worse than in any November since 1893. They are even worse than the poor return reported last month, and will probably not exceed 75,000 tons, which will be far below the November average, and will be more than 40 per cent. worse than the best November, which was in 1896, when 124,400 tons were shipped. The shipments up to 23rd reached only 52,830 tons, against 58,455 tons last month, and 82,415 tons in November, 1903, to 23rd. In ordinary times such unsatisfactory figures would have greatly weakened the market.

Ordinary business in Cleveland pig iron has improved this week, and prices of all qualities have been advanced, and foundry numbers have touched the highest figures that have been known this year. The value of No. 3 has also come nearer to that of warrants than has been the case for several weeks. Both makers and second hands have done business this week mainly at 46s. per ton for early f.o.b. deliveries of No. 3, and now not less than that will be taken by anyone. No. 4 foundry iron has gone up to 45s., and the lower qualities have risen 1s. per ton. There was considerable room for improvement, for No. 4 forge, which in the summer realised even a better price than No. 3, was last week 4s. per ton cheaper, the usual difference being 1s. per ton. The quotations for these lower qualities were practically stationary at the lowest figures of the year, while those for No. 3 and for warrants went up rapidly. On account of this great difference in values every ironmaster lately has set himself to get out of his furnaces as much No. 3 as possible, and the consequence has been that the output of these lower qualities was reduced, and more No. 3 was made. Thus the output of forge iron is no longer in excess of requirements, and it is not now necessary to press sales of it. This has enabled producers to put up the price of No. 4 forge to 43s., of mottled to 42s., and of white to 41s. Speculative operations have had little to do with the rise in these qualities, for they are not found in the public warrant stores, and the buyers are practically the consumers.

It is satisfactory to note an improvement in the demand for East Coast hematite pig iron, and a further advance in the prices. Thus, mixed numbers are now at 52s. per ton, No. 1 at 52s. 6d., and No. 4 at 49s. These are 2s. 6d. per ton above the recent lowest rates, but relatively they are still considerably cheaper than Cleveland foundry iron, for, with No. 3 of the latter at 46s., makers of hematite should be getting 56s. for mixed numbers. Speculation has had little to do with the rise in hematite iron, which may be attributed to an increased consumptive demand. The rates of freight for the conveyance of Rubio ore have been reduced, as was expected, but this has not brought down the price of the ore delivered to the consumers here, for the Spanish mine-owners, taking advantage of the better prices of the pig iron, have put up their quotations, and the rate, delivered c.i.f. Tees, is 14s. 7½d.

The output of Cleveland ironstone for some time past has been short of the requirements, and ironmasters, who have not been able to get all they needed, have had to import foreign ore to mix with their Cleveland stone. The Skinningrove Iron Company had to blow out a furnace because enough stone was not forthcoming. This arises chiefly from a lack of miners. If it had not been for the short supply of Cleveland ironstone a number of the furnaces which were producing hematite iron would have been set to make ordinary Cleveland iron, for which relatively so much more satistory prices could be got.

Business continues to show a slight improvement in some

branches of the manufactured iron and steel industries, but as yet buyers have not seen their way to pay increased prices. The Scotch steel plate makers have officially advanced the price of their steel ship plates to £5 15s., less 5 per cent., but that has not led to any change in quotations here, for it practically brings Scotch prices up to those of the North of England, which for long have been at £5 12s. 6d., less 2½ per cent. Iron ship plates are at £6, less 2½ per cent.

This week two cargoes, in all 3200 tons, of steel plates have been imported into Sunderland from the United States for one of the Wearside shipbuilding firms. This is a portion of the 5000 tons reported to have been bought some time ago, and one of the Tyneside shipbuilding firms also ordered 5000 tons.

Steel ship angles are obtainable at £5, less 2½ per cent.; steel bars are at £6, and iron bars at £6 2s. 6d., both less 2½ per cent. Heavy steel rails are at £4 10s. net at works, and steel railway sleepers at £6 5s. net.

The wages question in the shipbuilding industry of the North-East Coast has this week been one of the most prominent subjects of attention, and it is sincerely hoped that it may be amicably settled. A stoppage of work at the shipyards at any time is most undesirable, but it would be positively disastrous with trade so depressed all round, and the winter to face. Some time ago the masters felt it absolutely necessary to give notice that piece rates would be reduced 5 per cent., and other wages 1s. to 1s 6d. per week, and these reductions, it was stated, would take effect from Tuesday of this week. On Monday the masters had a conference at Newcastle with the representatives of all the sections of men affected. The latter asked that either the claim should be withdrawn, or that the notices should be postponed for a month. The employers naturally could not see their way to agree to the first proposition, and they were equally averse to hanging up the claim for a month. They agreed, however, that the notices should be held over for another week, and in the meantime the men are voting by ballot at their various lodges whether they shall concede the employers' claim One satisfactory feature is that the men's various societies are acting in concert, so that the employers' will not have to negotiate with each section separately. It will be remembered that last year, when all the other sections had agreed upon accepting the reductions claimed, the joiners refused and struck work, that strike lasting a long time, and throwing out of employment a large number of men who had agreed to the reduction That will be obviated now, for either all will strike or all accept the reduction. It is a much more satisfactory proceeding than regulating the wages piecemeal. It is believed that a stoppage of work will be avoided. Taking into account the almost unprecedentedly low prices that have had of late to be accepted for new steamers there can hardly be a doubt that builders are entitled to some relief in the cost of labour.

Last week-end the Teesside Bridge and Engineering Company, Limited, Middlesbrough, placed in position at South Shields a very large landing stage which they have constructed for the Tyne Commissioners' ferry traffic. The pontoon is 340ft. long and 50ft. wide, and it is connected with the shore by a bridge 125ft. long by 23ft. broad. This is intended for vehicular traffic only, separate roads being provided for vehicles leaving or approaching the ferries. Another bridge 125ft. long by 18ft. broad will be provided for the sole use of foot passengers. The old pontoon was removed and the new one moored in about twenty hours, the vehicular bridge being put into position likewise.

The coal trade is less active than it was, except in the gas coal branch. The house coal people find that the improvement in their trade is at least a month later than usual, as the weather has been so mild, but now the demand is rather brisk. Best steam coal can readily be bought at 9s. per ton f.o.b., and smalls at 3s. 9d. Best gas coal is at 8s. 1½d. per ton. The tendency in coke prices is rather upward in sympathy with the advance in pig iron values. Medium coke is at 14s. 3d. per ton delivered at the Middlesbrough furnaces. Both the Northumberland and Durham Miners' Associations have passed resolutions in favour of a minimum wage basis being recognised in the arrangements of the Conciliation Board.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been considerable activity in the iron trade this week. The substantial advance in the price of warrants has begun to tell upon consumers, who have been buying iron more freely. The opinion is still strongly held that the rise in prices is the result of a speculative movement. However this may be, the advance is certainly now strongly affecting business generally. The manufacturers have been obliged to raise the prices of both manufactured iron and steel, and it is just possible that the movement may have some beneficial effect. The purchases of pig iron in the last few days have included considerable quantities for delivery three months and even six months hence.

Business has been done in Cleveland warrants from 46s. 9d. to 46s. 3½d. cash; 46s. 11d. for delivery in twenty-three days; 46s. 3d. ten days; and 47s. to 46s. 5d. one month. Transactions are also quoted at 47s. 2d. two months; 47s. 1½d. to 46s. 8d. three months; and 46s. 6d. for delivery in four months. There has been little or no business either in Scotch or Cumberland warrants. The former are quoted 52s. 9d., and the latter 54s. 1½d. per ton.

Prices of Scotch makers' iron are 6d. to 1s. higher owing to the strength of the warrant market. G.M.B., f.o.b. at Glasgow, is quoted No. 1, 53s.; No. 3, 50s.; Carnbroe, No. 1, 54s.; No. 3, 50s. 6d.; Clyde, No. 1, 56s. 6d.; No. 3, 50s. 6d.; Langloan, No. 1, 64s.; No. 3, 54s.; Gartsherrie, No. 1, 57s.; No. 3, 51s.; Summerlee, No. 1, 57s.; No. 3, 51s.; Coltness, No. 1, 63s. 6d.; No. 3, 53s. 6d.; Glengarnock, at Ardrossan, No. 1, 58s.; No. 3, 51s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 52s.; No. 3, 49s. 6d.; Dalmellington, at Ayr, No. 1, 52s.; No. 3, 49s.; Shotts, at Leith, No. 1, 58s.; No. 3, 51s.; Carron, at Grangemouth, No. 1, 57s. 6d.; No. 3, 51s. 6d. per ton.

There is a fair business doing in Scotch hematite pig iron, which has been advanced 6d. Merchants quote 56s. 6d. per ton for delivery at the West of Scotland steel works.

Since last report one furnace has been transferred from hematite to ordinary iron, and there are now 40 making ordinary, 38 hematite, and 6 basic, the total of 84 furnaces thus in operation in Scotland comparing with 87 at this time last year.

For the first time for months the stock of pig iron in Glasgow warrant stores shows the small reduction of 10 tons, and now amounts to 9514 tons, being 224 tons less than at the beginning of the year.

The shipments of pig iron from Scottish ports in the past week amounted to 5531 tons, compared with 5541 in the corresponding week of last year. There was despatched to the United States 20 tons, Canada 100, South America 50, India 95, Australia 206, France 60, Germany 295, Holland 332, China and Japan 50, other countries 70 tons, the coastwise shipments being 4253 tons, compared with 2385 in the corresponding week of last year.

The arrivals of Middlesbrough pigs at Grangemouth were 10,770 tons, being 270 more than in the corresponding week. There is, however, a total decrease in these imports since the beginning of the year amounting to 98,236 tons.

There has been rather more inquiry for finished iron in the last few days, and makers report that work is coming to hand somewhat more freely. There is still, however, much room for improvement, for in some districts the shifts are not fully employed.

The Scotch makers of galvanised iron have advanced the price of sheets and plates 5s. per ton, and a further increase is under consideration.

The representatives of the Scotch Steel Trade Combination met in Glasgow this week, and resolved to advance the price of ship plates to £5 15s. per ton, and angles to £5 5s., these rates being 2s. 6d. per ton higher than the figures formerly current. There are reports to the effect that merchants are purchasing considerable quantities of steel billets from America at advantageous rates, but, of course, this material is not immediately available.

Comparatively few new shipbuilding orders are reported this week up to the time of writing. The rates quoted by shipbuilders have been extremely low. It is reported that for ordinary cargo steamers about £5 5s. per ton has been quoted. It is now, however, stated that proposals for new vessels can hardly be looked at unless at from 10s. to 15s. above the rate mentioned. This improved tendency is, of course, one of the effects of the upward movement in pig iron. There is rather more activity this week in the coal trade. The sudden occurrence of extremely cold weather, with frost and snow, has given a great impetus to the household branch of the trade. In some districts, however, there has been considerable interruption to traffic by snowstorms, which have blocked the railways. The coal shipments from the Scottish ports are in the aggregate somewhat higher than in the preceding week. While the clearances at Fifeshire ports have fallen off, this decline is more than made up by increased exports elsewhere. Coal prices are generally as before, but the tendency is firmer.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

ON Monday Sir M. Hicks-Beach came to Cardiff to act as independent chairman and arbitrate upon the appeal for a 5 per cent. reduction in colliers' wages, formally proffered by the employers, but opposed by the men. The matter was carefully considered by the arbitrator; Mr. Kirk the auditor's, statement that the selling price of coal for the past three months had been 12s. 4d. was noted; and after attentively listening to the arguments of employers and colliers, the decision was given in favour of a reduction of 5 per cent., bringing the rate to 38¾ above the standard of 1879. This will work out at a gain to the employers of 6d. per ton. It was shown that prices were receding, and several collieries stopped, owners being unable to make them pay.

The effect on the market has been slight, if any, and I hear little complaint from the men who must see the justice of the reduction.

The P. and O. coal contract for 200,000 tons at a price under 13s. has not gone to "Lewis Albion," as announced by a London journal, but to Lewis Merthyr Colliery, the Albion Company, or under its old name the Cilfynydd, and other collieries. The Argentine railway contract for 150,000 tons has been secured by the Standard at 12s. 6d. to 13s. The Buenos Ayres and Rosario contract for 120,000 tons steam coal has gone to the Yorkshire Rhondda. This week it was stated on 'Change, Cardiff, that on Tuesday 10,000 tons of best Admiralty coal had been bought through local merchants on Japanese account. The prices are not publicly known. Russia, too, is in the market, and shipments are taking place. Here, again, secrecy obtains, though price and port of shipment are known to a few.

The steam coal trade, for prompt especially, continues to be disappointing. As one coalowner observed this week, the promise of a few weeks ago has not been fulfilled. Leading coalowners are fairly well sold to the end of the year.

This week ruling prices, Cardiff, were: Best steam, at 13s. 3d. to 13s. 6d.; slight abatement made in cases of spot shipment. I have heard of 13s. and of 13s. 1½d., but quotations are as given. Best seconds are at 12s. 6d. to 12s. 9d., but good seconds were obtainable, mid-week, from 11s. 6d., and drys from 11s. 9d. to 12s. 3d. Best small steam are easier, 7s. to 7s. 3d.; seconds, 6s. 6d. to 6s. 9d.; inferiors, 5s. 9d. to 6s.; best house coal, 16s. 3d. to 17s.; seconds, 13s. 6d. to 14s.; ordinaries, 12s. to 12s. 6d. An appreciable improvement in demand is setting in for these coals on account of the early winter. House coal owners anticipate a brisk demand between now and Christmas. Little change has taken place in Monmouthshire coal; best, Newport shipment, is quoted at 11s. 6d. to 11s. 9d.; seconds, 10s. 9d. to 11s. 3d.; Eastern Valleys, 10s. 3d. to 10s. 9d.; No. 3 Rhondda, 13s. to 13s. 6d.; through, 12s. to 12s. 6d.; smalls, 9s. 6d. to 10s.; No. 2 Rhondda, 9s. 9d. to 10s.; through, 8s. 3d. to 8s. 6d.; small, 6s. 6d. to 6s. 9d. Patent fuel, 12s. 6d. to 13s.

In the Swansea market anthracite is decidedly firmer, especially the best; nuts in demand; rubbly culm still weak, 5s. to 5s. 6d.; duff, as low as 3s. to 3s. 6d.; best malting is quoted at 21s.; seconds, 18s. 6d. to 20s.; large, 10s. to 12s. 6d.; cobbles, 16s. 6d. to 18s. 6d.; machine nuts, 17s. 6d. to 20s.; peas, 9s. 6d. to 12s.

Steam trade dull; best from 13s. 3d. Rhondda No. 3, 13s. 3d. to 13s. 6d. Patent fuel, 11s. 9d. to 12s.

Shipment last week was better, over 11,000 tons despatched. Pitwood remains firm at all ports. At Cardiff this week prices touched 19s. 6d., and signs of continuing strong were prominent. Newport, 19s. to 19s. 3d.; Swansea, 19s., were ordinary quotations.

The Swansea coal trade last week was limited to 52,000 tons, the prevalence of fog hindering tonnage from coming in; and this week general port trade promises to be slack from the heavy storms. Complaints of slackness also prevail at several of the western collieries, and many are only doing three days' work a week. In the case of the Maesteg drift accident the number of deaths has amounted to three. The man charged with having acted as engineer, in the absence of the regular one, has been committed for manslaughter.

The question of the Welsh coal trade, demands of foreign navies, the 1s. tax, and Professor Boyd Dawkins' views as to the permanence of present output and proposal to curtail export, were all intelligently dealt with by the President of the Chamber of Commerce, at the Cardiff mayoral banquet this week. The president deprecated any interference with the export of coal, and showed that if our collieries were not kept in a state of efficient working it would be impossible in a crisis to put them into working order in anything like a reasonable time. The argument used for the reduction of exports and retention of coal for future generations was an idle one. With respect to the reserves of coal held by Wales, the Commission now sitting would soon give its decision; but it was tolerably clear that the men of the present, their children, and grandchildren would never know the want of coal. As for the 1s. tax, which has told heavily on many collieries, he maintained that the 1s. had had no preventive effect. If increased to £1, it would not prevent powerful nations from getting it.

There has been an unusual quantity of scrap iron, old rails, and steel sent into Wales from various ports, Plymouth figuring with London; and the surmise is that outsiders regard the iron trade as brisk. This is not so, and it is only by keeping wages at a minimum that the men are kept going with tolerable regularity. An order for 4000 tons steel is stated to have been placed in the Welsh market in consequence of a labour difficulty in the North, but as Dowlais can turn out 4000 tons steel rails in a week, this is not an important matter. Pig iron has come in from Spain—a variation of the ore exports—and 700 tons steel bars from Philadelphia, with general cargoes from Holland, Belgium, and Antwerp.

A slightly better tone was evident on 'Change Swansea mid-week, and it was reported that an improvement was shown, and an advance in quotations recorded. In pig iron there was an advance all round, 1s. 3d. in Scotch, 2d. in Middlesbrough, and 6d. in hematite.

In finished iron and steel there has been a steady demand for local tin bars, as distinguished from foreign bars, the inferiority of which, experts say, will certainly tell on users who confine themselves to the foreign. In tin-plates a scrap sale at the Beaufort, realising good prices, shows that the trade is buoyant and prospects unimpaired. Stocks slightly increased this last week. In the Swansea Valley good results are being shown at Messrs. Baldwin's. Output of steel bar in the valley good, but four furnaces out temporarily.

A special list of prices has been issued referring to tin-plate at Swansea, and will be found of interest.

Cokes, I.C. 20 × 14, 11s. 10½d. to 12s.; 18¾ × 14 and 19¼ × 14 quoted up to 12s. 6d.; 20 × 10, 17s. 3d. to 17s. 6d.; I.C. 28 × 20, 56 sheets, 12s. 3d. to 12s. 6d.; same size for 112 sheets, 24s. to 24s. 3d. per box; odd sizes at a basis of 12s. 6d.; wasters dearer, and in free demand, 20 × 14 C.W. realising 11s. 4½d. to 11s. 6d. per box; 18¾ × 14, 1s. 3d. less per box; double box of 28 × 20 C.W., 23s. to 23s. 3d. Charcoal, 12s. 9d. for I.C. 20 + 14, and inferior according to quality. In good request: Ternes, 21s. 9d. to 22s. per box for I.C. 28 × 20. Black plates firm at £8 15s. to £8 17s. 6d. per ton basis for finished qualities, f.o.b. Wales, 4 per cent. discount.

Ruling figures iron and steel Swansea this week were as follows:—Pig iron, Glasgow warrants, 52s. 9d.; Middlesbrough No. 3, 46s. 2d.; hematites, Cumberland, 54s.; Welsh bars, £6 2s. 6d. to £6 5s.; sheet iron, £8 to £8 7s. 6d.; steel, £8 to £8 2s. 6d.; steel rail, heavy, £4 5s. to £4 10s.; light, £5 5s. to £5 10s.; Bessemer bars, £4 4s. to £4 5s.; Siemens best, £4 5s. to £4 7s. 6d.; spelter brisk, all works busy, £25 17s. 6d., one quotation gives 10s. less; block tin, £132 10s.; lead, £13 7s. 6d.; Spanish, 5s. less; copper: Chili bars, £66 2s. 6d.; iron ores, 13s. 6d.

It is stated in the Cardiff district that Mountford Phillips and Co., engineers, Brierley, Staffordshire, intend opening at Llantrissant, a place favourably situated for a sea port, railway and colliery conveniences.

Port business at Swansea would be brisk with more favourable weather; as it is, notwithstanding fogs and storms, returns are good, and steamers this week are loading for America and Russia.

Newport was quite brisk one day last week, sixty-one vessels coming into the various docks and wharves.

Bristol is discussing, equally with Cardiff, a rather ominous rumour that Sir Alfred Jones will probably make Southampton and not Bristol his port of arrival in connection with West Indian trade.

Cardiff dispatched 70,000 tons coal on Friday last.

THE NEWPORT HARBOUR COMMISSIONERS WEEKLY TRADE REPORT.

STEAM coal in better request, owing to the supply of tonnage having come on. House coal in fair demand. The quantity of coal shipped for the week ending November 19th was 96,551 tons—foreign, 77,455 tons; coastwise, 19,096 tons. Imports for the week ending November 22nd, 6107 tons:—Manganese ore, 2800 tons; pig iron, 1200 tons; scrap, 565 tons; cement, 140 tons; pitwood, 7742 loads.

Coal—Best steam, 11s. 6d. to 11s. 9d.; seconds, 10s. 6d. to 10s. 9d.; house coal, best, 15s.; dock screenings, 6s.; colliery small, 5s. 3d. to 5s. 6d.; smiths' coal, 9s. Pig iron—Scotch warrants, 53s. 6d.; Middlesbrough No. 3, 46s. 7½d.; Middlesbrough hematite, 54s. 6d. Iron ore—Rubio, 13s. 6d.; Tafna, 14s. 6d. Steel—Rails, heavy sections, £4 2s. 6d. to £4 2s.; light ditto, £5 5s. to £5 7s. 6d. f.o.b.; Bessemer steel tin-plate bars, £4 2s. 6d. to £4 5s.; Siemens steel tin-plate bars, £4 5s. to £4 7s. 6d., all delivered in the district, cash. Tin-plates—Bessemer steel, coke, 12s. 6d. to 12s. 9d.; Siemens, coke finish, 12s. 9d. to 12s. 10½d. Pitwood—19s. 3d. to 19s. 6d., ex ship. London Exchange telegrams—Copper, £66 to £66 2s. 6d.; Straits tin, £132 10s. to £132 12s. 6d. Freights active, rates steady.

CATALOGUES.

MIRRLEES WATSON COMPANY, Limited, Glasgow.—A four-page pamphlet just published by this firm deals with the Diesel oil engine, of which we understand over 900, of a total aggregate power of 45,000 brake horse-power, are now in use. The construction and operation of the engine are well known to our readers.

TANGYES LIMITED, Cornwall Works, Birmingham.—Catalogue No. 62 deals with steam boilers, the various types including vertical cross-tube, vertical multitubular, colonial tubular for wood fuel, semi-portable multitubular, marine, and externally-fired boilers. The neatness with which the book is produced is worthy of special mention.

WOLSELEY TOOL AND MOTOR CAR COMPANY, Limited, Adderley Park, Birmingham.—This company has just issued a hand-book for the users of the Wolseley motor cars. It is of handy form, well indexed, clearly printed, and contains readable diagrams. The letterpress describes, in language simple enough to be understood by persons with no special engineering knowledge, the functions of those portions of the mechanism of the Wolseley motor car which should be understood by every owner and user.

RAILWAY ENTERPRISE IN WALES.—Most of the railways are seeking powers, and have put in Bills for promotion next session. Cardiff Railway, instead of asking for powers for a competitive route to Sirhowy Valley, seeks for running powers over the Barry line, or any other new railway which would connect the Rhymney, Barry, and Brecon and Merthyr Railway with the branches of the London and North-Western, and Great Western Railway. They also seek powers to run over the Rhymney to the Aber Colliery; over the Barry, north of that junction; over the Brecon and Merthyr, northward from the new Barry junction; and over the London and North-Western, and Great Western, northward from the new projected Barry extension. Barry extensions are for entering into Sirhowy from the line and viaduct forming in the Rhymney Valley. This will touch virgin mineral ground by a short line through the hill.

SMART ENGINEERING FEAT.—The work in connection with the ferry improvements which are being carried out at North and South Shields on behalf of the Tyne Improvement Commissioners, by the Teesside Bridge and Engineering Works, Limited, of Middlesbrough and London, is now nearing completion. About six weeks ago the existing landing stage and bridge at North Shields was removed and the new pontoon landing stage and bridge were fixed in position—the operations having been carried out on a Sunday most successfully. The work was advanced another important stage on Sunday last, when the old staging and bridge at South Shields were taken away, and the new landing stage—340ft. long by 50ft. wide—and bridge—125ft. long by 23ft. wide—were fixed in place. The contractors obtained possession of the site at 10 p.m. on Saturday, the 20th inst., and the whole of the work—which presented many elements of difficulty—was completed without a hitch by the contractors in the afternoon of the following day.

SHEFFIELD UNIVERSITY COLLEGE.—The Court of Governors of the Sheffield University College meets to-day, Friday. The annual report to be presented for adoption states that there is every promise that the new college will be ready for opening by the end of June or the beginning of July next year. Close on £12,000 will be needed for the provision of scientific apparatus, &c. Towards the £170,000 required for additional buildings and endowments, £110,000 has been promised, leaving £60,000 to be raised. The Coal Mining Committee of the College have formulated a scheme for a great extension of the work of their department and for its financial support, which they have submitted to the colliery owners and managers of the district. Their purpose is to create an institution for instruction, for testing, and for research in mining questions comparable with the metallurgical department of the College. It is proposed that the department shall be managed by a committee, which shall contain a large representation of the industry itself.

NOTES FROM GERMANY.

(From our own Correspondent.)

THERE is, as usual, very little of interest or importance to relate in connection with the iron and steel industry over here, the position all round being still rather unsettled, and, without taking a pessimistic view of things, far less satisfactory than was generally anticipated for this season of the year.

In Rheinland-Westphalia only in a few instances has the trade in iron and steel been showing more life than previously; the majority of the shops and factories complain of securing but a poor amount of fresh work.

Export has been increasing, but this cannot make up for the falling off in the inland demand, because very low prices have to be taken if ironmasters wish to secure foreign contracts. South America has been coming forward with some fair orders for railway material; Argentina sent in some large contracts for locomotives and general rolling stock. The plan of a railway line from New York, through Mexico, to the principal places on the east coast of South America, appears to have met with approval, and representatives are reported to have been sent over to Europe for the purpose of securing the supply of railway requirements by contracts. Concerning the different departments of the iron industry, a little more strength can be noticed in the pig iron trade, while semi-finished steel is only well inquired for on foreign account. Underquoting is specially strong in the bar trade, and impedes business a good deal; hoops and girders are quiet, and the plate trade, as well as the business in wire, must be regarded as unfavourable. The members of the Steel Convention resolved to raise the prices for bars and flat bar iron, the former on M. 108, the latter on M. 105 p.t. free Oberhausen, the advance coming into force at once.

The physiognomy of the Silesian iron market has been a little more bright than formerly; the fact that, principally, an agreement has been formed regarding the Silesian Steel Convention may have tended to slightly improve the tone of the market. The present "Union of Sale" of the Upper-Silesian rolling mills is to be dissolved, and instead, the Upper-Silesian Steel Convention will come into force on the 1st of January, 1905. For crude iron and for most articles of manufactured iron a moderate inquiry comes in. In girders rather more was done than previously; sheets are very dull, and so are welded pipes, while for plates a fair inquiry comes in. After a good deal of talking and trouble, the German Copper Convention has finally been formed.

According to the *Berliner Tageblatt*, a representative of the American Steel Trust is expected to come to Germany on a visit to Mr. Thyssen, whose activity and endeavours in the iron industry have been attracting attention in America. Thyssen is going to receive his guest at Schloss Landsberg in Westphalia, and the International Steel Convention is to be the most important topic of conversation.

There was a little more life stirring on the Silesian coal market this week than last, still sales are comparatively small, in consequence of the mild weather, and stocks are fairly heavy. In coke a good trade is done.

From the Rhenish-Westphalian coal market pretty favourable accounts have been received upon the week; a rise in quotations will very likely take place shortly, increasing inquiry being reported for house coal and also for several sorts of engine fuel. The zinc industry purchases pretty freely, and shipments to Belgium and Holland are comparatively large. The business in briquettes has improved, and so the intended restriction in output of 25 per cent. has not been strictly adhered to. The prices recently fixed at the coalowners' meeting of the Rhenish-Westphalian Coal Convention are from 0·50 to M. 1 p.t. higher than those of last year.

A pretty firm tone is reported to characterise the Autro-Hungarian iron market. Pig iron, as well as bars and sectional iron, have been in fair request; plates remain dull. The North Railway has just given out orders for fourteen locomotives; six express and two tender locomotives were given to the Wiener Neustadt locomotive shops, while six goods train locomotives were granted to the Floridsdorfer machine factory. The value of the order is 1·1 million crowns.

There is but a slight change for the better noticeable in the Austrian-Hungarian coal trade. Demand, though better than in previous month, has yet been rather lower than it is expected to be at this time of the year. Gas coal and coal for coke-making are best inquired for.

Satisfactory accounts are, on the whole, received from the French iron industry. In all departments except Midi and Nord employment has been improving rather than otherwise.

Although the tone is confident, business transactions on the Belgian iron and steel market have been comparatively limited upon the week. With regard to prices, only rails and girders can be reported in a satisfactory condition.

In the centre of the Charleroi coal district a strike is on, which is likely to extend. This strike, however, may be the cause of the decided firmness that could be felt last week in the Belgian coal industry, and the Flénu pits will find but little difficulty in carrying their prices now.

MESSRS. JAMES HOWDEN AND CO., of Glasgow, inform us that they have appointed Mr. W. H. Owen, who has for some time occupied a responsible position on the staff of their dynamo, engine, and turbine department, to represent them in London in succession to Mr. F. C. Gibbons. Mr. Owen has now taken up his duties at their London office, Billiter-buildings, 22, Billiter-street, E.C.

MESSRS. ERNEST SCOTT AND MOUNTAIN, Limited, have a complete installation in hand, consisting of a steam engine of 300 indicated horse-power, together with generator and a complete equipment of electric motors for driving the underground haulage, pumps, &c., for the Bedminster Coal Company, of Bristol. They are also carrying out extensions of the plant at the Whitwick Colliery, near Leicester, and have an order in hand for extensions to the electrical machinery which they supplied to Messrs. North's Navigation Collieries, Limited, a few years back.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

9th November, 1904.

24,256. HEATING SAD IRONS, J. A. Tayler, Maidstone, Kent.
24,257. SWIVEL CONNECTION for VALVES, T. E. B. Brown, London.
24,258. BOOTS, E. A. Uhthoff, London.
24,259. SHEET RECEIVER, W. H. Lock, W. F. Wood and B. J. J. Goulding, London.
24,260. MACHINES for WIRE DRAWING, J. A. Horton, London.
24,261. MEANS for COMPRESSING GASES, H. Baker, London.
24,262. FORMING WIRE-DRAWING DIES, J. A. Horton, London.
24,263. PARQUETRY, P. Stevens, London.
24,264. STUDS, J. C. Alexandri, London.
24,265. OPERATING VENETIAN BLINDS, J. D. Leach, London.
24,266. LOCK for FASTENING STRAPS, E. J. M. L. de Saint-Quentin, London.
24,267. TYPEWRITERS, G. R. Hingelberg, D. G. Jones, and F. L. Berry, Sheffield.
24,268. CARDING ENGINES, W. Bradley, London.
24,269. CLIPS EMPLOYED in TENTERING MACHINES for STRETCHING FABRICS, A. A. Whitley, G. Bentley, and J. Nuttall, London.
24,270. PREPARING DOUGH for BREAD MAKING, P. Davies, London.
24,271. MACHINES for GRINDING PUNCHES, J. A. Horton, London.
24,272. VALVE GEAR for ENGINES, O. Schwade, London.
24,273. TRAP for MICE, F. R. Redman, London.
24,274. INSTRUMENT for USE with PNEUMATIC TIRES, E. E. Michelin, London.
24,275. GOVERNING MECHANISM for TURBINES, J Wilkinson, London.
24,276. ALTERNATING CURRENT MOTORS, V. A. Fynn, London.
24,277. FILES, J. Walker, jun., London.
24,278. COOLING of MOTORS, J. Lea, J. J. Crichton, and W. C. Lea, London.
24,279. APPARATUS for GENERATING ACETYLENE GAS, M. Jackson and The Sunbeam Acetylene Gas Company, Limited, London.
24,280. CARRIAGES for DECK BEAMERS, C. Schofield, London.
24,281. PNEUMATIC HAMMERS, W. P. Thompson.—(*Werkzeug Maschinenfabrik, Berner and Co., Germany.*)
24,282. APPARATUS for LOOSENING HAY, W. Sutcliffe, Liverpool.
24,283. UMBRELLAS, E J. Walker, London.
24,284. HAY RAKES, E. C. Blackstone and R. E. Watts, London.
24,285. DYEING TEXTILE MATERIALS, G. de Keukelaere, London.
24,286. ANODES, S. O. Cowper-Coles, London.
24,287. ROLLERS for PRINTING PURPOSES, S. O. Cowper-Coles, London.
24,288. FOOD for ANIMALS, F. Livingstone.—(*A. Stein, Austria.*)
24,289. SUSPENSION RAILWAY, N. Loring, London.
24,290. PRODUCING COLOURED PHOTOGRAPHS, G. Koppmann, London.

10th November, 1904.

24,291. AIR TUBE for PNEUMATIC TIRES, S. S. Cavanagh, Geashill, King's Co., Ireland.
24,292. GENERATION of ACETYLENE GAS, C. W. Wallace, Barnes, Surrey.
24,293. METHOD of PRODUCING COKE, J. R. Breckon, Newcastle-upon-Tyne.
24,294. CLAMPING DEVICE, E. Barnes, Sheffield.
24,295. RAILWAY SIGNALS, J. R. O'Driscoll, Lowestoft, Suffolk.
24,296. BURNERS for LIQUID FUEL, W. Galloway, Glasgow.
24,297. MANUFACTURE of VOLATILE OILS, A. H. Gittings, Roseville, near Bilston.
24,298. MENTHOL and CAMPHOR, A. H. Gittings, Roseville, near Bilston.
24,299. PORTABLE FOLDING PLATFORMS, S. Gath, Bristol.
24,300. HAIR-PINS, T. W. and F. M. Madsen, Stockport, near Manchester.
24,301. HATCHET, W. Phillips and W. Robins, Rhondda Fach, Glamorganshire.
24,302. AUTOMATIC CONTINUOUS SIGNALS for TRAINS, T. S. and R. W. Heslop, W. B. Bigge, and J. W. Hodgson, Stockton-on-Tees.
24,303. CUTTING COAL, W. Young. W. Clark, and H. Green, Manchester.
24,304. PNEUMATIC TIRES and WHEEL RIMS, J. Butler, Manchester.
24,305. COLLAR FRAME, I. Kleinmann, Berlin, N O, Germany.
24,306. SAFETY PINS, H. F. Neuss, Birmingham.
24,307. CASE for SURGICAL PURPOSES, J. G. Woolham, Manchester.
24,308. CHARGING INCLINED RETORTS, T. and R Redman, Bradford.
24,309. CHECKING SHUTTLES in LOOMS, R. Boothroyd, Huddersfield.
24,310. LIGHTING by MEANS of ELECTRIC LAMPS, G. Wilkinson, Harrogate.
24,311. ART of PHOTOGRAPHY, A. H. Gittings, Roseville, near Bilston.
24,312. BALL VALVES, F. J. Brazier, London.
24,313. RAILWAY SIGNAL BELLS, C. E. P. Gabriel, Birmingham.
24,314. ACETYLENE GAS GENERATORS, R. H. S. Webb, Scarborough.
24,315. DUST-REMOVING APPARATUS, J. H. Walker.—(*P. Kestner, France.*)
24,316. ELECTRIC ARC LAMPS, A. Eckstein and A. E. Angold, Manchester.
24,317. SHIP DRAUGHTSMAN'S WEIGHTS, H. J. Hedderwick, Glasgow.
24,318. LAVATORIES, J. Smith, Glasgow.
24,319. MANUFACTURE of TUBES, J. Menzies, Glasgow.
24,320. SOLES for BOOTS and SHOES, P. E. Legard, Wakefield.
24,321. PIVOT ATTACHMENT for RAILWAY WAGONS, P. Gillespie, Edinburgh.
24,322. SAWS for STONE-CUTTING MACHINES, C. H. Baxter, Bradford.
24,323. ELECTRIC TRACTION, J. Birkbeck, Bradford.
24,324. SHAVING BRUSHES, F. Jeanes, Bristol.
24,325. DOMESTIC FURNITURE, W. and A. Stewart, Glasgow.
24,326. MOTION TRANSMITTER for MOTIVE POWER ENGINES, A. J. B. Légé, London.
24,327. SELF-LIGHTER, A. Connely, Glasgow.
24,328. OXIDISING and DEOXIDISING AGENTS, A. H. Gittings, Roseville, near Bilston.
24,329. PRODUCING FIGURED INDIGO DYED TEXTILE FABRICS, W. Mycock, Manchester.
24,330. MANUFACTURE of INDIA-RUBBER, A. H. Gittings, Roseville, near Bilston.
24,331. MOTOR CARS, C. H. Stafford, Nottingham.
24,332. PERINEUM NEEDLES, T. Fletcher, Bromsgrove.
24,333. OBTAINING PRODUCER GAS FREE of TAR, A. Desgraz, London.
24,334. RECORDING SPEED of STATIONARY ENGINES, C. E. Player, Penryn, Cornwall.
24,335. TAPE MEASURE, G. Rarp, London.
24,336. ARTIFICIAL COMPOSITION FUEL, C. H. Carpentor and S. L. Davis, London.
24,337. WATER-CLOSETS, F. C. Zacharie, London.
24,338. WIRE STRETCHERS, N. L. Hathorn, London.
24,339. TRAMWAY RAILS, E. J. Elford, London.
24,340. FLUSHING CISTERNS, C. H. Brandreth and A. T. Handley, Brighton.
24,341. ELECTRIC SWITCHES, O. D. Lucas, London.
24,342. CARBONS for ELECTRIC ARC LAMPS, F. J. Green, London.
24,343. ELECTRIC SIGNS, J. Heinemann, London.
24,344. NON-REFILLABLE BOTTLES, A. C. Sherwood.—(*A. S. Kellam, New South Wales.*)
24,345. STEAM TRAPS, R. Garston, S. Alfred, and C. Hardisty, London.
24,346. MANUFACTURE of GATE POSTS, J. A. Reavell, London.
24,347. MEANS of TRANSMITTING POWER, G. E. Clare, London.
24,348. INTERNAL COMBUSTION ENGINES, N. W. H. Sharpe, London.
24,349. PINS for SECURING WEARING APPAREL, G. Espey, London.
24,350. WASH-BOARDS, J. Fels.—(*W. H. Scott, United States.*)
24,351. ROTARY ELECTRIC MACHINES, M. Walker, London.
24,352. BRAKES for RAILWAY VEHICLES, J. W. Cloud, London.
24,353. MEANS for SUPPLYING WATER, A. A. Biggs, London.
24,354. WHEELS for VEHICLES, B. P. Laws, London.
24,355. TYPEWRITING MACHINES, Deutsche Schreibmaschinen-Ges. G. m. b. H., London.
24,356. REGULATING TEMPERATURE in ROOMS, C. W. Wallace, Barnes, Surrey.
24,357. INKING RIBBONS of WRITING MACHINES, Deutsche Schreibmaschinen-Ges. G. m. b. H., London.
24,358. MECHANISM for ELECTRIC ARC LAMPS, G. D. Mantle, London.
24,359. WRITING MACHINES, Act.-Ges. für Schreibmaschinen-Industrie, London.
24,360. SAWS, J. Hill, London.
24,361. CANDLE-STICKS or HOLDERS, T. R. Voce, Birmingham.
24,362. WRITING MACHINES, Act.-Ges. für Schreibmaschinen-Industrie, London.
24,363. SEPARATION of VOLATILE COMPOUNDS, A. G. Green, London.
24,364. BICYCLE-RIDING DISPLAY APPARATUS, C. Alonso-Perez, London.
24,365. GAUGES, D. Cockerell, London.
24,366. BINS for SUGAR, B. Young, London.
24,367. WRITING MACHINES, Act.-Ges. für Schreibmaschinen-Industrie, London.
24,368. PROCESS for INFUSING HOPS, A. E. Hewer, London.
24,369. ELECTRIC EMERGENCY LAMPS for THEATRES, F. Brandt, London.
24,370. COOLING AIR, C. F. Dixon-Johnson, London.
24,371. ARMOURED CONCRETE CONSTRUCTION, E. Coignet, London.
24,372. LIQUID FUEL BURNERS, C. Leistner, London.
24,373. MOTOR CYCLES, F. Hegel, London.
24,374. SEPARATING ALKALINE SALTS in SUGAR JUICE, B. T. King.—(*C. H. Bertels, Belgium.*)
24,375. TREATING or PURIFYING WINES, J. H. Hunter, London.
24,376. CLUTCH MECHANISM, W. G. Clifton, London.
24,377. BRIDGES, G. Barker, London.
24,378. OVERHEAD ROADWAYS, G. Barker, London.
24,379. CENTRIFUGAL SEPARATORS, W. H. Scott and R. Williamson, London.
24,380. MILITARY HELMETS, P. J. L. Stone, London.
24,381. METAL PLATES for CONSTRUCTION of FLOORS, H. Rigby, London.
24,382. FILING DEVICE, J. S., J., and P. Reekie, London.
24,383. RING SPINNING FRAMES, W. P. Thompson.—(*P. Burkard, France.*)
24,384. COMBINED MOUTH GAG and ELECTRIC LIGHT, J. S. D. MacCormac and The Dental Manufacturing Company, Limited, London.
24,385. DEVICES for PROTECTING the HAND, G. H. Jervis Liverpool.
24,386. GRINDING MILLS, R. Stanley, London.
24,387. TYPEWRITERS, H. W. Higham, London.
24,388. ELECTRIC CIRCUIT BREAKERS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,389. CONTROLLING DEVICES for ELECTRIC MOTORS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,390. INSULATORS for LIVE RAILS, O. Erlands, London.
24,391. COMBINED SPANNER, KEY and SCREWDRIVER, G. H. Lawson, London.
24,392. POSTAL ENVELOPES, A. J. Bacon, London.
24,393. MANUFACTURE of BREAD CAKE, A. MacPhail, London.
24,394. CONNECTING ELECTRIC CIRCUITS, D. Couverchel, London.
24,395. NON-SLIPPING COVER for RUBBER TIRES, J. M. L. Mills and C. F. G. Ambrose, Chippenham.

11th November, 1904.

24,396. SELF-ADJUSTING STUFFING-BOX PACKING, J. Hosgood, Cardiff.
24,397. DROP HAMMERS, E. S. Brett and the Brett's Patent Lifter Company, Birmingham.
24,398. GIG and HARNESS SADDLES, J. and J. Noake, jun., Birmingham.
24,399. ELECTRIC TOOLS, P. Schiemann, Glasgow.
24,400. INCANDESCENT GAS MANTLE, C. J. Sutton and J. Rudd, Bolton, Lancs.
24,401. AUTOMATIC VARIABLE CUT-OFF and GOVERNOR GEAR, G. Riddett, Glasgow.
24,402. FLUSHING CISTERNS, M. J. Adams, Stocksfield-on-Tyne.
24,403. BOXES for PULVERULENT SUBSTANCES, W. Pochin and J. H. Richardson, Manchester.
24,404. NON-REFILLABLE BOTTLES, T. K. Crossley and G. Jones, jun., Liverpool.
24,405. LAP WINDING MACHINES, S. Whittaker, Manchester.
24,406. ORNAMENTAL PARTS of BEDSTEADS, J. T. Petford, Manchester.
24,407. SCRAPING IRON in the PROCESS of ROLLING, H. Bunch, Wolverhampton.
24,408. TREATMENT of HIDES, C. Fell, Keighley, Yorks.
24,409. TEDDING MACHINES, H. Bögelmann, Berlin, W., Germany.
24,410. SUPPORT for CHIMNEY POT, A. E. Settle, Manchester.
24,411. DOMESTIC APPLIANCE for SLICING, J. Charter and R. Wormald, Manchester.
24,412. DYEING FIBROUS MATERIALS, C. Owens, Manchester.
24,413. CAPSTANS, G. H. Baxter, Glasgow.
24,414. TAPE-ACTION PIANOS, R. Eastwood, Manchester.
24,415. LOOMS for WEAVING, R. Greenwood and J. Bolton, Manchester.
24,416. INNER TUBES of PNEUMATIC TIRES, J. W. Gordon, Glasgow.
24,417. BRAKE MECHANISM for WINCHES, F. Lobnitz, Glasgow.
24,418. PICTURE CORD HOOKS, E. Jones, J. Patterson, and T. S. Jones, Halifax.
24,419. SLIDING WINDOWS, E. Jones, G. Patterson, and T. S. Jones, Halifax.
24,420. METHOD of PREPARING FOOD, M. M. Wilson, Glasgow.
24,421. MEANS for TRANSMISSION of MOTION, S. E. Alley, Glasgow.
24,422. INVERTED INCANDESCENT LAMPS, M. Kay, London.
24,423. ELECTRICITY METERS, Chamberlain and Hookham, Limited, and S. H. Holden, Birmingham.
24,424. SPONGE HOLDER, J. MacGregor, Leith.
24,425. SOCKETS for HOLDING CANDLES, G. A. Phillips, Birmingham.
24,426. BRICK KILNS, J. Hamblet, Birmingham.
24,427. LETTER FILES, A. J. Johnson and W. L. Smith, Birmingham.
24,428. MANUFACTURE of PRECIOUS STONES, A. H. Gittings, Roseville, near Bilston.
24,429. TELEPHONE SYSTEMS, W. Aitken. Liverpool.
24,430. PRODUCING PROTEID, G. Mitchell, London.
24,431. REGISTERING POOL TABLES, G. Kiddling Magdeburg Germany.
24,432. SYNCHRONISATION APPARATUS, B. Bonniksen Coventry.
24,433. AUTOMATIC FIRE-ESCAPE, S. Scotter, Brighton.
24,434. REED TRIMMER, W. F. Taylor. London.
24,435. LOCKS for CYCLES, S. Bardgett, London.
24,436. SPINNING FRAMES, A. Willoquet, London.
24,437. MAKING TABLETS for CACHETS, F. W. Warwick.—(*R. Jablonsky, ———.*)
24,438. FERRULES for STUFFING-BOXES, A. M. Denham, London.
24,439. WASTE-PREVENTING TAPPING PIPE, J. Griffin and W. H. Making, London.
24,440. MANUFACTURE of SOAP, F. Holoubek, London.
24,441. PRESERVING LIQUIDS, H. J. R. Hemming, London.
24,442. SPRING WHEELS for VELOCIPEDES, J. Nutsford, London.
24,443. PNEUMATIC HAMMERS, C. Schofield, London.
24,444. RAILWAY and TRAMWAY VEHICLES, G. Gibbs, London.
24,445. OBTAINING TIN from SLAGS, C. A. L. W. Witter, London.
24,446. FILTER PRESS FRAMES, P. Mégra, London.
24,447. FLUSHING TANKS, L. Minot, London.
24,448. MULTIPLE-FILAMENT INCANDESCENT LAMP, J. Klopfenstein, London.
24,449. HEATING SYSTEMS, D. M. Nesbit and Ashwell and Nesbit, Limited, London.
24,450. CONTROLLING SUPPLY of FLUIDS, H. B. Arundel and J. Higginson, jun., London.
24,451. IMPREGNATION of WOOD, A. J. Boult.—(*Hülsberg and Co., Germany.*)
24,452. CYCLE BRAKE CLUTCHES, F. T. Gottschalk, London.
24,453. SEPARATING DUST from AIR, S. Simmons, London.
24,454. SPOOLS of TYPEWRITING MACHINES, A. J. Boult.—(*C. Spiro, United States.*)
24,455. VEHICLE WHEEL RIMS, W. Struckand E. Weller, London.
24,456. MACHINES for DYEING FURS, La Société C. and E. Chapal Frères and Compagnie, London
24,457. WEDGE MUTE for USE in BANJOS, W. Weyhorn, London.
24,458. ORE CONCENTRATING TABLES, J. F. C. Abelspies, London.
24,459. DOOR SPRINGS and CHECKS, A. W. Adams, London.
24,460. BOATS, W. C. Foy, London.
24,461. VARIABLE SPEED PULLEYS, W. C. Kimber, London.
24,462. TOOTHED GEAR WHEELS, F. Hutchins, London.
24,463. ROLLERS for TREATMENT of FIBROUS MATERIALS, F. Hutchins, London.
24,464. FIELD WINDINGS of SERIES-WOUND DYNAMO-ELECTRIC MACHINERY, A. F. Hills, D. Urquhart, and A. E. Honey, London.
24,465. ROTARY HAIR BRUSHES, J. Kohnstam, London.
24,466. ELECTRICAL CONDUCTORS, S. O. Cowper-Coles, London.
24,467. WASHING GAS, Kirkham, Hulett, and Chandler, Limited, and S. Hersey, London.
24,468. APPARATUS for ROLLING, W. Tafel, Liverpool.
24,469. DRIVING MECHANISM for MOTOR CARS, H. Büssing, Liverpool.
24,470. ELECTRIC GAS APPARATUS, P. C. Hewett, London.
24,471. MEASURING MACHINE for LIQUIDS, J. W. Flower, London.
24,472. WHEELS for ARTILLERY CARRIAGES, D. Mills, London.
24,473. MOTOR PLOUGHS, J. Brey, London.
24,474. FRET SAWS, F. Schmidt, London.
24,475. BELT CUTTING MACHINES, F. Müller, London.
24,476. REGULATING DESCENDING AUTOMOBILES, H. Saurer, London.
24,477. ELECTRIC ARC LAMP, F. M. Lewis, G. W. L. Case, and the Reason Manufacturing Company, Limited, London.
24,478. GAS METERS, W. Clark.—(*E. F. M., E. K. P. Haas, L. J. E. Weigelt, F. E. and K. L. Haas, Germany.*)
24,479. SUCTION DEVICE for OIL ECONOMISER, N. Platt, London.
24,480. COOLERS for MOTORS, H. Windhoff, London.
24,481. TAKING FOOT MEASUREMENTS, C. Wilhelmi, London.
24,482. COMPOSITION, F. Duschek and L. Witte, London.
24,483. CUFF LINKS, J. L. N. Willis, London.
24,484. COMBINATION GARMENT, F. Löwy, London.
24,485. ELECTRIC METERS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,486. FOLDING HAT, M. B. A. Bartholomew and H. Stewart, London.
24,487. MAKING CONFECTIONERY, J. Robins and the Confectioner's Vegetable Colours and Fruit Essences Company, Limited, London.
24,488. CIGARETTE MAKING MACHINES, A. Benoit, J. Guéniffet, J. Nicault, and E. Dangerr, London.
24,489. VAPORISING HYDROCARBONS, D. Albone and F. Boswell, London.
24,490. ACETYLENE STORM LAMPS, F. W. Howorth.—(*J. Margreth, Germany.*)
24,491. FLANGED TUBES, J. Arnold and J. Leech, London.
24,492. ROLLER BEARINGS, T. J. F. Ryland, London.
24,493. BALL BEARINGS, T. J. F. Ryland, London.
24,494. MAKING a CHEMICAL SUBSTANCE, H. D. Dakin, London.
24,495. VALVES, G. Smith, London.
24,496. WASHING MACHINE, C. Schröder, Hanover, Germany.
24,497. COOLING VESSELS, F. Saade, Hanover, Germany.

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24,498. WASHING MACHINES, D. Evans, Ystalyfera, Glam.
24,499. WATER HEATERS. E. W. Lancaster, London.
24,500. FOLDING SEAT, G. Pell, Charfield, Gloucestershire.
24,501. SIGNS, S. T. and F. H. Mowbray, London.
24,502. WEIGHT for SEA FISHING, M. F. Blake and F. C. Brown, London.
24,503. LOCK NUT and BOLT, R. H. Kon, London.
24,504. MOTOR LAMPS, W. H. and W. Dee, and F. J. Edginton, Birmingham.
24,505. DYEING TEXTILE MATERIALS, T. de Naeyer, Manchester.
24,506. COMPRESSED AIR MOTOR TORPEDOES, W. H. Webb, W. G. Brettell, and A. J. Adamson, Liverpool.
24,507. SMELTING of IRON, W. H. Webb, W. G. Brettell, and A. J. Adamson, Liverpool.
24,508. HAIRDRESSERS' REQUISITE, R. A. Clarke, Birmingham.
24,509. STRAPS for PARCEL CARRIERS, T. A. Smith.—(*F. Vial, Victoria.*)
24,510. TIE CLIP, A. E. Downing, Birmingham.
24,511. DRYING SEMI-LIQUIDS, A. J. Oxford, S. H. Buxton, and L. Oxford, Birmingham.
24,512. FASTENING SOLES to BOOTS, E. E. Bailey, Southampton.
24,513. REGISTERING on PRINTING MACHINES, W. Carter, Glasgow.
24,514. AUTOMATICALLY OPENING GATES of LIFTS, J. A. Steven, Glasgow.
24,515. SMOKELESS FURNACE for STEAM GENERATORS, A. Dunn, Birkenhead.
24,516. SPINDLES for TWISTING FRAMES, J. Sharp and Sons, Limited, and A. Duncanson, Glasgow.
24,517. COVERS for DRIVING CHAINS, A. Farnell Coventry.
24,518. FISHING ROD TACKLE, C. Mitchell, London.
24,519. CYCLES, C. D. Simms, London.

24,520. Apparatus for Taking-off Boots, H. P. Miller, London.
24,521. Hockey Sticks, G. E. Marshall, Liverpool.
24,522. Apparatus for Suspending Curtains, W. E. Knight, Edinburgh.
24,523. Rock Drills, T. Warsop, Coniston, R.S.O., Lancs.
24,524. Pencils, T. Tarleton, Liverpool.
24,525. Flexible Tubings, R. A. Fletcher, Birmingham.
24,526. Mechanism for Automobiles, J. Platel, Birmingham.
24,527. Process for Production of Protrid, G. Mitchell, London.
24,528. Free Engine Gear for Motor Bicycles, The Eadie Manufacturing Company, Limited, R. W. Smith, and H. M. Phillips, Birmingham.
24,529. Looms for Weaving, M. H. Sidebotham and J. Chambers, Halifax.
24,530. Fasteners for Ladies' Dresses, W. J. Andrews, Glasgow.
24,531. Administering Medicine to Babies, E. Berry, Manchester.
24,532. Doubling and Winding Frames, A. Hitchon, Accrington.
24,533. Mechanically-operated Lubricators, The Wolseley Tool and Motor Car Company, Limited, and H. Austin, Wolverhampton.
24,534. Wilson Snaffles, W. Ashwell and A. Gameson, Birmingham.
24,535. Operating Sliding Doors, P. Wheeler, Birmingham.
24,536. Manufacture of Guanidine Salts, T. Ewan and J. H. Young, Glasgow.
24,537. Monument in Place of Tombstones, J. Carter, Armley, near Leeds.
24,538. Electrical Fuses, B. and G. Thomas, Manchester.
24,539. Automatic Electric Switches, B. and G. Thomas, Manchester.
24,540. Lamp Burners, B. Werner, Germany.
24,541. Spring Cases for Watches, R. Pleissner, Germany.
24,542. Waffle Irons, P. A. Hörmann, Germany.
24,543. Anti-crib-biting and Wind-sucking Appliance for Horses, J. A. Craft, Reading.
24,544. Automatic Air-pressure Flushing Cisterns, J. W. Straughan, Sanderstead, Surrey.
24,545. Distributing Oil upon Fibres, F. Spivey, London.
24,546. Fireproof and Sound-deadening Wall, T. W. Rickson, London.
24,547. Furnaces, H. A. Birrell, London.
24,548. Grates, A. E. Johnson, London.
24,549. Clothes Hanger for Wardrobes, L. Diefenthal, Germany.
24,550. Cases for Displaying Goods, A. M. Edelstein, London.
24,551. Printed Side up Deliveries of Printing Machines, W. H Lock and T. M. North, London.
24,552. Excavating Machines, A. J. Ducellier, London.
24,553. Apparatus for Cleansing Plates, M. Findjian, London.
24,554. Manufacture of Benzenes, L. Scholvien, London.
24,555. Ladies' Hat-pin, W. Stevens, London.
24,556. Nut-locks, M. P. Carpenter, London.
24,557. Rock Drills, M. A. Adam.—(*Armaturen und Maschinenfabrik-Westphalia Akt.-Ges., Germany.*)
24,558. Carburetting Apparatus, La Société Anonyme Westinghouse, London.
24,559. Locks and Latches, H. G. Voight, London.
24,560. Electric Testing Clip, H. Frankel, London.
24,561. Internal Combustion Engines, H. M. Taylor, London.
24,562. Binders for Scaffolding, P. M. Justice.—(*E. C. Koop, Germany.*)
24,563. Briquetting Manganese Ores, T. Rouse and H. Cohn, London.
24,564. Wheel Construction, W. A. Gilmer, London.
24,565. Curtain Poles, H. D. Roe, London.
24,566. Stamping Machines, G. K. P. Hoffmann, London.
24,567. Lamp Burners, W. A. Heelas, London.
24,568. Automatic Cut-off Valves, J. Hübner and I. Mayer, London.
24,569. Supply of Current to Electric Vehicles, O. H. Baldwin, London.
24,570. Turbines, Belliss and Morcom, Limited, and A. Jude, London.
24,571. Pneumatic Tires, R. J. Crowley and A. Blackman, London.
24,572. Internal Combustion Engines, A. de Dion and G. Bouton, London.
24,573. Dynamo-electric Machines, A. F. Batchelder, London.
24,574. Rain-water Pipe Bends, C. Schmücker, London.
24,575. Sugar Moulds, J. C. F. Lafeuille, London.
24,576. Locks, A. G. Baker, London.
24,577. Rests for Displaying Goods, H. E. Hobbs, London.
24,578. Indicating Bolts, H. Hope and Sons, Limited, and W. Haywood, London.
24,579. Manufacture of Vases, A. G. Harley-Jones, London.
24,580. Buffers for Use on Motor Vehicles, F. R. Simms, London.
24,581. Fire-lighters, F. A. Hofmann, London.
24,582. Coffee Mixture, W. Langer, London.
24,583. Separating Dust from Air, W. E. Allington, London.
24,584. Disc Shears, T. Raitza and P. Oximek, London.
24,585. Treatment of Copper Ore, G. H. Blenkinsop, London.
24,586. Boring Mechanism, J. V. Brejcha, London.
24,587. Furnaces, W. P. Thompson.—(*W. N. Best, United States.*)
24,588. Axles, H. Nicholson, Liverpool.
24,589. Treatment of Wood, &c., E. Burnet, Liverpool.
24,590. Wooden Stoppers, J. Sandham, Liverpool.
24,591. Internal Combustion Engines, H. F. Fullagar, London.
24,592. Pump, W. A. Rohr, London.
24,593. Engine, W. A. Rohr, London.
24,594. Self-supplying Air Compressors, W. A. Rohr, London.

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24,595. Bogies, P. Kreisel, Cologne, Germany.
24,596. Bottles, W. G. Verrall, Eastbourne.
24,597. Tire Bands, A. Franklin and A. T. Sadler, Birmingham.
24,598. Self-acting Closet Washer, H. H. Hold, Barnsley, Yorks.
24,599. Incandescent Lamp Guard, J. Devitt and C. Maskrey, Manchester.
24,600. Lubricators, C. B. Crawshaw and D. Bannister, Halifax.
24,601. Heating Compressed Air, C. B. Crawshaw and D. Bannister, Halifax.
24,602. Reversing Motion for Planing Machines, W. and A. R. Copley, Halifax.
24,603. Military Game Apparatus, B. H. Thwaite, London.
24,604. Power Factor Indicators, W. E. Sumpner, Sevenoaks, Kent.
24,605. Wattmeters, W. E. Sumpner, Sevenoaks, Kent.
24,606. Feeding Sand from Locomotives, T. Boardman, Bristol.
24,607. Apparatus for Filling Sacks, N. L. Thomsen, Birmingham.
24,608. Safety Pin, R. F. Neuss, Birmingham.
24,609. Biscuits, A. Alltimes, D. Wilton, and C. Gillespie, Glasgow.
24,610. Winding Thread, R. F. and J. Alexander and Co., Limited, and J. Mackie, Glasgow.
24,611. Measuring Machines, R. Thornley, Manchester.
24,612. Bottle Openers, R. M. Stothert, Atherton, near Manchester.
24,613. Driving Mechanism, W. H. Thicket and J. Halliwell, Hull.
24,614. Boots, J. A. Mitchell, Bradford, Yorks.
24,615. Scraping the Insides of Chimneys, T. R. Parr, Derby.
24,616. Game, L. Dodson and T. A. Jarman, Swindon, Wilts.
24,617. Cycle Clutches, A. Smith, London.
24,618. X-ray Obstructing Material, W. M. Martin, Redruth, Cornwall.
24,619. Glazing for Roofs, K. Edwards, Belfast.
24,620. Electric Clocks, I. H. Parsons and A. E. J. Ball, Leicester.
24,621. Detecting Pieces of Metal in Cloth, W. Thomson, Manchester.
24,622. Removing Antimony from Alloys of Gold, J. S. MacArthur, Glasgow.
24,623. Needles for Sewing Machines, E. J. Hall, Glasgow.
24,624. Wire-cutting Plyer, H. B. Srawley, Birmingham.
24,625. Centrifugal Creamers, N. G. K. Husberg, Stockholm, Sweden.
24,626 Enamelling Metallic Surfaces, J. W. Sankey, Wolverhampton.
24,627. Telephone Signalling Devices, J. Macfee, London.
24,628. Mail Carts for Children, W. S. Dove, London.
24,629. Preserving Cut Flowers, J. Pfister, Manchester.
24,630. Bleaching Materials, J. D. Tomlinson.—(*F. Haas, Germany.*)
24,631. Breaking up Hard Doo Biscuits, C. S. Watson, Bristol.
24,632. Electrically-operated Switches, A. Eckstein and E. Parker, Manchester.
24,633. Golf Flag Sticks and Flag Tins, G. P. Cracknell, London.
24,634. Transmitting Signals to Locomotives, R. C. Wetherell, London.
24,635. Reel Attachment for Unwinding, S. H. Donaldson, London.
24,636. Lighting Street Lamps, A. G. Kent-Johnston, London.
24,637. Scales, C. W. Brecknell, London.
24,638. Petroleum Burners for Stoves, T. B. Ferguson, jun., London.
24,639. Valves for Water Supply Tanks, J. A. Staples, London.
24,640. Braces, R. Poore, London.
24,641. Lime Extractors, H. White, H. J. Cobbold, and J. F. McNeal, London.
24,642. Internal Combustion Heat Engines, J. L. Bogert, London.
24,643. Side-cars for Motor Cycles, C. D. Leechman, London.
24,644. Looms for Making Mats, C. Rigelaford and A. W. Green, London.
24,645. Production of Iron and Steel, J. W. Duncan, London.
24,646. Speed Indicators for Motor Cars, I. Garforth and F. Hughes, London.
24,647. Elevator-controlling Mechanism, J. F. Murphy, London.
24,648. Games, L. M. Dieterich, London.
24,649. Egg Carrier, J. G. Dawson, London.
24,650. High-pressure Centrifugal Blowers, R. J. Hodges, Bedford.
24,651. Trouser Stretcher, A. Holmer, London.
24,652. Horse Collars, J. Ihle, London.
24,653. Turbine, R. C. F. Ogilvie, Upper Long Ditton, Surrey.
24,654. Printing Machines, W. Fairweather.—(*R. F. Rogers, United States.*)
24,655. Feed Gauge for Printing Machine, E. Pollock, London.
24,656. Brush Pad, T. Shaw, London.
24,657. Joint for Rainwater Pipes, R. H. Moores, London.
24,658. Repeating Rifles, Fabrique Nationale d'Armes de Guerre Société Anonyme, London.
24,659. Safety Bolt for Small-arms, Fabrique Nationale d'Armes de Guerre Société Anonyme, London.
24,660. Fittings for Electric Lamps, G. A. Walker, London.
24,661. Game, J. H. Rowland, London.
24,662. Treatment of Eggs, W. A., A. H., and H. W. Holmes, London.
24,663. Electrical Valve Controlling System, I. G. Waterman, London.
24,664. Draught Regulator for Grates, B. J. Mouat, London.
24,665. Guards for Vehicle Windows, E. Lombray, London.
24,666. Razor-stropping Device, J. Velasco, London.
24,667. Fire-escapes, M. Freshfield, London.
24,668. Ladies' Protector, A. McK. Normanby, London.
24,669. Manufacture of Abylnaphthylaminesulphonic Acid, C. D. Abel.—(*Act.-Ges. für Anilin Fabrikation, Germany.*)
24,670. Extraction of Water from Mineral Substances, O. Imray.—(*Farbwerke vorm. Meister, Lucius and Brüning, Germany.*)
24,671. Buffing Mechanism for Railway Carriages, J. Willison, London.
24,672. Manufacture of Crystallised Methyl, O. Imray.—(*The Society of Chemical Industry in Basle, Switzerland.*)
24,673. Induced Draught for Furnaces, W. Downie, London.
24,674. Lubricating Device, W. H. Proctor, London.
24,675. Electric Brakes for Trams, R. B. Ransford.—(*The American Electric Brake Company, United States.*)
24,676. Speed Gear, S. Diamant, London.
24,677. Photographic Apparatus and Film, P. T. Hahn, London.
24,678. Gumming Machine, E. O. Champ, London.
24,679. Sewing Machines, W. S. North, Liverpool.
24,680. Cigarette Machines, J. M. Martinez, London.
24,681. Shirts, M. Auzinger, London.
24,682. Mine Track Systems, J. Whitehead, London.
24,683. Order Cards, S. Schwarz, London.
24,684. Mechanical Puzzle, J. F. Roberts, London.
24,685. Production of Formaldehyde, A. Boake, Roberts and Co., Limited.—(*W. H. Allen, United States.*)
24,686. Evaporating Apparatus, S. M. Lillie, London.
24,687. Needles for Gramophones, H. M. and A. C. Dennes, London.
24,688. Multitubular Steam Generators, S. D. Armand and F. L. M. Robillard, London.
24,689. Electric Storage Batteries, L. N. J. Roselle, London.
24,690. Pocket Folding Knives, G. Gray, London.
24,691. Rubber Vulcanising Apparatus, C. F. Kite, London.
24,692. Alternating-current Systems, A. Grammont, London.
24,693. Albums, F. Voege, London.
24,694. Incandescent Light Mantles, F. Nusch.—(*G. Mortimer-Sterling, France.*)
24,695. Motor Cycles, W. F. von Scholley, London.
24,696. Appliance for Affixing Stamps, J. Purkiss, London.
24,697. Machine for Folding Newspapers, J. M. Twomey, London.
24,698. Electric Switches, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,699. Electric Motor Control, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,700. Systems of Electric Motor Control, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,701. Electric Motor Control, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,702. Bridge for Musical Instruments, A. D. Grover, Boston, Mass., U.S.A.

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24,703. Brakes for Motor Cycles, J. G. Looker, Heaton Moor, near Stockport.
24,704. Gears for Self-propelled Vehicles, A. Downs, Croydon, Surrey.
24,705. Leaf Turner and Holder, E. H. Griffin, London.
24,706. Self-enclosed Motors, W. T. Jones, Hengoed, Glam.
24,707. Cover for Seats of Motor Cars, W. M. Holmes, Leicester.
24,708. Electrically-propelled Vehicles, C. W. G. Little, Beckenham, Kent.
24,709. Machine for Producing Power, G. Kölling and H. Behr, London.
24,710. Games of Skill, J. H. Gibb, Glasgow.
24,711. Presses for Linen, W. H. Johnson, Manchester.
24,712. Making Bricks, L. F. Kwiatkowski, Manchester.
24,713. Refining Oils, J. Lewkowitsch, London.
24,714. Self-acting Window Lock, H. L. Parish, Torquay.
24,715. Incandescent Globe Lamps, J. W. Lea and J. H. Perrins, Birmingham.
24,716. Tea-table Dish, G. W. Carter, Norbury, Surrey.
24,717. Drawing-off Rollers of Combing Machines, F. and A. Lightowler, Bradford.
24,718. Barrel Root Cutters, J. Gutteridge, Stamford, Lincoln.
24,719. Holding Rings on Show-cards, M. W. Lister, Birmingham.
24,720. Pad for Packing Purposes, J. Baldwin, Birmingham.
24,721. Stands for Bicycles, K. D. D. Grazebrook, Birmingham.
24,722. Electric Tramcars, W. Whittaker, Burnley.
24,723. Refrigeration, W. H. Webb, W. G. Brettell, and A. J. Adamson, Liverpool.
24,724. Metal Travelling Trunk, W. H. and B. H. Jones, Wolverhampton.
24,725. Motors and Driving Gear, F. W. Lanchester, London.
24,726. Fluid-pressure Reciprocating Engines, F. W. Lanchester, London.
24,727. Odd Time Premium Calculator, F. W. Tyler, London.
24,728. Regenerator Tubes, H. Townsend, Wakefield, Yorks.
24,729. Pipe Joint, J. C. Haller and R. H. Machell, Halifax.
24,730. Portable Lantern for Advertising, E. Avon, Penarth, Glam.
24,731. Obtaining Magnesium Oxide, J. Plummer, Colinton, Midlothian.
24,732. Inverted Incandescent Lamps, M. Kay, London.
24,733. Making Pigments, J. F. Bennett and J. Mastin, Sheffield.
24,734. Setting Concrete, J. Thompson, Dundee.
24,735. Collapsible Receptacles, J. Beresford, Manchester.
24,736. Dollies used in Washing Operations, G. T. Gould, Manchester.
24,737. Boot and Shoe Fastener, A. M. Gent, Levenshulme.
24,738. Lathe Beds, J. T. Nicolson and D. Smith, Manchester.
24,739. Oiling Bearings of Spindles, J. Boyd, London.
24,740. Ribs for Corsets, E. J. Menzies, West Ferry, Forfar.
24,741. Cardboard Boxes for Butter, F. H. Hague, London.
24,742. Igniting Mechanism for Motors, F. R. Lorenz, London.
24,743. Advertising Cards, S. Loewenthal, London.
24,744. Electrical Alarm Clocks, H. F. Schmidt, London.
24,745. Stencil Duplicating Apparatus, B. J. B. Mills.—(*A. B. Dick Company, United States.*)
24,746 Mathematical Instrument, B. J. B. Mills.—(*J. Lombard, France.*)
24,747. Firelighters, E. J. Fletcher, London.
24,748. Hair-pin, L. O. Fuller, Dartford, Kent.
24,749. Sandals, W. Cohn, London.
24,750. Fluid-pressure Brake Apparatus, J. W. Cloud, London.
24,751. Machine for Sharpening Knives, E. Wilson, London.
24,752. Water-tube Boiler, E. Scopoli, London.
24,753. Knitting Machines, G. F. Lee, London.
24,754. Penholders, N. Struck, London.
24,755. Removable Shoulder Straps, W. Wulff, London.
24,756. Horseshoes, H. Bartley, London.
24,757. Horseshoes, H. Bartley, London.
24,758. Operating a Sliding Member of a Clutch, B. G Bateman, A. F. Pumfrey, and J. Gibson, London.
24,759. Railway Vehicle Couplings, Fried. Krupp Akt.-Ges., London.
24,760. System of Heating Water, R. W. Boyd, London.
24,761. Lifeboats, R. A. Brown, London.
24,762. Hammers, A. E. and A. E. Aldworth and T. A. Gooch, London.
24,763. Ventilating Public Conveniences, J. Harris, London.
24,764. Registering Sheets to Printing Machines, R. W. Horne, London.
24,765. Demolishing Wire Entanglements, N. Loring, London.
24,766. Chimney-sweeping Machines, A. Horobin, Birmingham.
24,767. Method of Sterilising Milk, H. J. R. Hemming, Lewisham.
24,768. Device for the Propulsion of Ships, F. Bell, London.
24,769. Electrical Commutators, Nalder Bros. and Thompson, Limited, F. H. Nalder, and O. Cox, London.
24,770. Signalling Device for Elevators, O. Imray.—(*F. S. Payne, United States.*)
24,771. Drawing Corks, N. P. Samuelsen, London.
24,772. Indicating Distances Travelled, O. Imray. (*W. Bruhn, Germany.*)
24,773. Lace-fastening Arrangements for Boots, F. Bräuninger, London.
24,774. Photographic Films, M. Bry, London.
24,775. Elevator Safety Appliances, W. T. Robinson and J. Casey, London.
24,776. Machines for Picking Cotton, G. A. Lowry, London.
24,777. Wire-drawing Devices, H. L. Thompson London.
24,778. Vulcanising Rubber Soles to Boots, G. F. Butterfield, London.
24,779. Cyclists' Trouser Clips, H. Myers and H. Wright, London.
24,780 Combing Machine Attachment, A. A. Sack, London.
24,781. Reducing Aluminium Metals, H. S. Blackmore, London.
24,782. Manufacture of Explosives, C. Duttenhofer, London.
24,783. Automatic Lighting of Gas Jets, F. Testor, London.
24,784. Apparatus for Opening Doors, N. Couland, London.
24,785. Furnaces, G. and T. Wilton, London.
24,786. Apparatus for Altering the Angles of Propeller Blades, C. A. F. Meissner, London,
24,787. Furnaces for Gas Retorts, F. Spencer, London.
24,788. Electric Arc Lamps, W. R. Whitney, London.
24,789. Amusement Apparatus, J. H. Maguire, London.
24,790. Range-finders, A. H. D. Riach, London.
24,791. Harmonicas, J. H. Mendles, J. A. Allen, and H. H. Nielson, London.
24,792. Machines for Making Bread, A. Zilcher, London.
24,793. Tobacco Pipes, J. Burghardt, London.
24,794. Folding Table, J. Lawson and J. Challis, London.
24,795. Stamping Soap, E. L. Cook and H. Bertram, London.
24,796. Cars for Tunnel Kilns, A. A. Gery, London.
24,797. Bellows, J. H Lamprey, London.
24,798. Apparatus for Producing Ozone, J. H. Lamprey, London.
24,799. Trouser Clips, H. W. Dover, London.
24,800. Facilitating the Aiming of Fire-arms, D. Spiller, London.
24,801. Bedsteads for Invalids, J. C. Anderson, London.
24,802. Suspension Springs for Vehicles, A. Mans, London.
24,803. Tool Handle Attachments, W. Asheri, London.
24,804. Apparatus for Cooling Air, J. C. Witter, London.
24,805. Explosion Engines, F. A. Haselwander, London.
24,806. Coal Drilling Machines, G. J. Robins, Liverpool.
24,807. Propelling Bodies Floating in the Air, G. Knapper, Liverpool.
24,808. Means for Treating Sewer Gas, G. J. Robins, Liverpool.
24,809. Device for Turning Music Leaves, S. R. Howson, Liverpool.

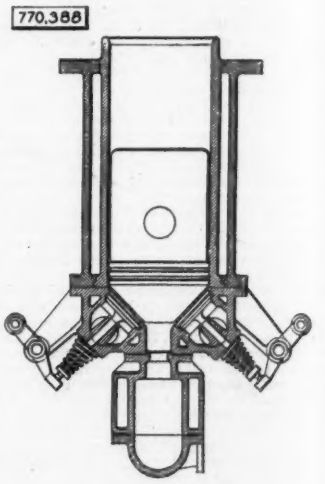
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

770,388. Internal-combustion Engine, *D. Roberts, C. James, and J. W. Young, Grantham, England.—Filed February 9th*, 1904.

Claim.—In an internal-combustion engine, the combination with the cylinder having an opening substantially in line with the axis of the piston, an air-inlet port located at one side of said opening and an exhaust port on the opposite side of said opening, of

770,388

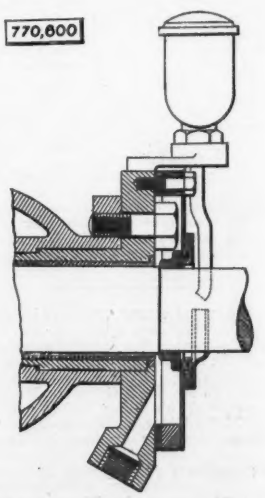


a vaporising chamber communicating with said opening and valves for controlling said inlet and exhaust ports, whereby on the opening of the exhaust valve the exhaust gases and air will sweep across said opening and partially exhaust the vaporiser of its contents of burned gases, substantially as described.

770,600. Spindle Bearing especially applicable to Centrifugal Pumps, *A. Morcom, Birmingham, England.—Filed April 21th*, 1903.

Claim.—In a pump, the combination of a rotatable spindle element, a stationary element of the pump within which said spindle element rotates, an annular

770,600



packing yieldingly secured fluid tight to one element of the pump and bearing fluid tight exteriorly against the other element thereof, and a conduit leading from the discharge side of the pump and serving to deliver water into the space between said packing and said stationary pump element which water serves to balance the atmospheric pressure on the outside of said packing.

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No. IV.*

CONCRETE AND REINFORCED CONCRETE.

In a short paper, M. A. Considère, Inspecteur Générale des Ponts et Chaussées, reviewed the development of this important modern method of construction. In France the practice is to reinforce compression members with longitudinal bars or rods connected at intervals by diaphragms or wires. In all calculations the transverse ties are neglected and the resistance of the metal is supposed to be added to the resistance of the concrete. But tests have proved that spiral rods or hoops give to the core of concrete gripped within them a crushing strength 2·4 times greater than that of longitudinal reinforcing members of the same weight. Hooped concrete is about twenty times more ductile than that reinforced longitudinally.

A paper by Captain Sewell, of the Engineer Corps, United States Army, pointed out the wide and varied uses of concrete at the present time, the latest applications being to piles and the walls of buildings. While the tendency to use wet concrete is very marked, to ensure thorough bonding in reinforced concrete and in works where impermeability is desired, better concrete can, in general, be made with a mixture requiring reasonable ramming to make it quake. Machine-made concrete was approved, although Captain Sewell thought that its economy had been very generally over-estimated, while it requires a rather large amount of concrete to pay for the plant. Seepage of water through concrete has caused trouble in fortifications and magazines, and a suggested remedy—which has proved effective—is to lay a 3in. top coat of rich, dense concrete, laid in small, independent squares, prevented from cracking by a network of steel bars, and having the joints caulked like the seams of a deck. Concrete, reinforced with steel, is now being very extensively used for bridges, dams, floors, buildings, &c., and the calculations for the strength of this material were discussed at some length.

Mr. Edwin Thacher, an American engineer who has given special attention to this class of work, gave a paper on Americanp ractice, in which he reviewed the various applications of concrete, with examples—buildings of monolithic and block construction, foundations, chimneys, tramway and building foundations, railway sleepers, dams, reservoirs, tunnel lining, streets, tanks, grain bins, piers, abutments, bridges, sewers, floors, piles, &c. He thought that reinforced concrete bridges, with spans of 500ft. or more, could be built with perfect safety, and often with economy. While approving of wet concrete, he thought the present tendency was to use too much water.

Herr Fr. von Emperger, an Austrian engineer, contributed a paper on concrete-steel bridges, including the three-hinged concrete arches at Steyer and Laibach, in Austria. Concrete-steel girder bridges were also mentioned, and the stresses under load were discussed mathematically.

Both Mr. Lesley and Mr. Humphrey spoke on the freezing of concrete work during construction, and showed that injury only resulted after repeated freezing and thawing.

Herr Erlinghagen, of Germany, spoke of the difficulties encountered in investigation; one of the principal difficulties is the determination of satisfactory methods of calculating stresses, another is the lack of definite information concerning the properties of materials used; still another is the uncertainty as to the adhesion of cement to steel; and a fourth is the variation, in different systems, of armoured-concrete construction.

Mr. R. J. G. Read, of London, spoke of using concrete piles on the Hennebique system, and described a 70ft. concrete tower for a water tank. Mr. Fuller remarked that the common description of concrete mixtures, as 1: 2: 4, or 1: 3: 6, is too vague and indefinite; it is necessary to state the size of the sand and stone if any clear idea of the nature of the concrete is to be given. Mr. Johnson favoured the use of steel bars of such form as to give a mechanical bond between the steel and the concrete, instead of relying upon adhesion alone.

MANUFACTURE OF CEMENT.

The paper on this subject, by Mr. R. W. Lesley, showed that the manufacture in the United States, in 1903, amounted to 20,897,973 barrels of Portland cement, 7,030,271 barrels of natural cement, and 525,896 barrels of slag cement. Very little Portland was exported, while 2,439,948 barrels were imported. During the past ten years American Portland cement has established its commercial and scientific reputation, and it has become possible to adopt new methods and machinery adapted to peculiar conditions as to fuel and labour by which the American makers were handicapped when working under European processes. Numerous companies operate their machinery by electric power. The Illinois Steel Company uses waste heat from the furnaces for the boilers of a generating plant, whose electric output is transmitted by cables to the company's cement works, eight miles distant. Extremely fine grinding is found to be necessary to produce the highest grades of cement, and the study of manufacturers is largely devoted to the problem of making this impalpable powder ready for the kiln at the lowest cost for power and repairs. The development of the industry in the United States, during the past ten years, is essentially due to the introduction of the rotary kiln, invented by Ransome, in England, some twenty years ago. The kilns are generally 60ft. long, by 5ft. diameter, but the kilns at Mr. Edison's new works are 150ft. long; these latter are not yet commercially successful. The output is about 200 barrels per day for a 60ft. kiln, 300 for 80ft., and 400 to 500 with kilns 107ft. long. High-speed gyratory grinders and slow-speed ball mills and tube mills are all in extensive use.

The marked progress is in the introduction of rotary kilns and improved forms of grinding apparatus. The quality of Portland cement has also shown a marked improvement, as far as fine grinding and tensile strength are concerned. A number of engineering and technical societies and the Association of Portland Cement Manufacturers have succeeded in uniting upon a standard specification. This will lead to great progress in the industry, enabling manufacturers to concentrate their efforts to meet one line of requirements rather than to meet the many hundreds of specifications now constantly brought before them.

Mr. Humphrey favoured compression tests rather than tensile tests, as concrete is rarely used in tension. He did not approve of cement inspection at the mills, as it necessitates too great capacity for storage; he rather advocated the use of "sand-cement," that is, an intimate mixture of sand and cement ground together to an exceedingly fine powder.

THE MANUFACTURE OF STEEL.

Mr. Bradley Stoughton, of the Department of Metallurgy at Columbia University, gave a lengthy paper on the metallography of steel; this was a very valuable production, but cannot well be abstracted. Mr. William Metcalf, a leading engineer, investigator, and manufacturer of steel, read a short paper comparing the production of steel in the United States for the years 1892 and 1902.

Total Annual Capacity, Tons.

	1892.		1902.
Bessemer	6,560,000		12,938,000
Bessemer-Clapp-Griffith	170,000		—
Open-hearth	1,550,000		8,289,750
Crucible	105,000		175,000
Total	8,385,000		21,402,750

Production of Steel Ingots and Castings.

Bessemer	4,168,435		9,138,363
Open-hearth	669,889		5,687,729
Crucible	84,709		112,772
Miscellaneous	4,548		8,386
Total	4,927,581		14,947,250
Total of the world (1889)	10,948,000	(1901)	30,680,000

In crucible tool steel there has been no improvement in quality for forty years, but there have been marked improvements in alloy steels and in Bessemer and open-hearth steel. This is particularly the case with the handling of large heats of open-hearth steel, producing a more uniform grade or quality. The result has been that open-hearth is now used for many purposes where crucible was formerly used, but not for fine lathe work, milling cutters, high-speed cutting tools, &c. While it does not seem possible to reduce the cost of crucible steel to a point where it can compete with open-hearth steel, there is the possibility of improving the latter so as to compete with the best crucible steel.

High-speed steel is the one remarkable, revolutionary development of the decade. In the necessary heat treatment, it reverses nearly all the best practice for carbon steel; and in its work it has practically revolutionised the machine business of the world. As far as it is developed at present, it consists usually of medium carbon, generally under 0·80, very little manganese, from 10 to 20 per cent. of tungsten or molybdenum, and, generally, from 3 to 4 per cent. of chromium, although some brands do not contain chromium. It is hardened by heating almost to fusion and quenching in an air-blast or in cold oil. It will make heavy cuts at a remarkably high speed for metal working, hence its name, causing a temperature that will blue steel chips and that would ruin instantly any carbon steel tool.

TESTS OF MATERIALS OF CONSTRUCTION.

Mr. Wm. R. Webster, in a paper on tests of steel, stated that the results are dependent, alike upon the heat treatment in manufacture and on the chemical constitution. At present, endeavours are being made in the United States to find better check tests of brittle steel, to prevent its being accepted and put in service.

A paper by M. Baclé, a French engineer, also discussed this question of brittleness.

Mr. W. A. Aiken's paper dealt with cement testing, and stated that the two most marked recent changes in practice are the following:—First, the recognition that the testing should be done at the place of manufacture; secondly, the tendency towards lowering the specification strength requirements in both neat and sand-mortar tests at early periods. M. Edouard Caudlot also had a short paper on testing lime and cement, and referred to studies for the substitution of a test determining the resistance to flexure instead of the tensile test.

The paper by Professor Gaetano Lanza, of the Massachusetts Institute of Technology, was on tests of timber, and pointed out the necessity of distinguishing between tests made on small pieces and on full-sized pieces. In commenting upon the paper on tests of steel, Sir Wm. White urged the importance of the bending test for determining the character of material, especially in regard to brittleness.

PUMPING MACHINERY.

Mr. Irving H. Reynolds, designer of the Reynolds type of Corliss engine, and consulting engineer for the Allis Chalmers Company, contributed a paper reviewing modern American practice in this line. The record for general efficiency is held by a 30,000,000-gallon vertical triple-expansion engine at Boston. With 185 lb. steam and 195ft. piston speed, an official test gave the following results:—

178,497,000 foot-pounds per 1000 lb. of steam.
163,925,300 foot-pounds per 1,000,000 B.T.U.
196 B.T.U. per indicated horse-power per minute.
10·335 lb. of steam per indicated horse-power per hour.
1·06 lb. of coal per indicated horse-power per hour.
21·63 per cent. thermal efficiency; or 22·58 per cent. including economiser.

Attempts to combine the economy of the crank and fly-wheel engine with the cheapness and simplicity of the direct-acting engine have not been successful, to any extent, except in the case of the Worthington compensating device, and engineers do not now consider this equal to the crank and fly-wheel type. The direct-acting duplex pump is commonly used for capacities up to 3,000,000 gallons, or even 5,000,000, and the guaranteed duty per 1000 lb. of dry steam is from 60,000,000 for compound condensing and 90,000,000 for triple-expansion condensing, or 110,000,000 and 130,000,000 if high-duty attachments are used. For crank and fly-wheel horizontal compound engines the duty ranges from 110,000,000 to 130,000,000; these are sometimes built for triple-expansion, but there is little to recommend this arrangement. The large vertical engines, however, are mainly triple-expansion. The Corliss valve gear is in practically universal use on high-duty engines, except some Leavitt engines with cam operated gridiron valves. It is customary to use steam jackets, and the receivers between cylinders are usually fitted with reheating coils or tubes in connection with the jackets. The pumps are usually double-acting for horizontal and single-acting for vertical engines. The speed is usually 200ft. to 250ft. per minute, and high-speed pumps, with positively controlled valves, have made no headway in the United States. At several plants now under construction, steam with a moderate degree of superheat, will be used; and a "promising possibility" for increasing the economy is the superheating of receiver steam by passing it through reheaters in the smoke flues of the boilers. Mr. Reynolds expressed the opinion that:—

Within the next ten years the economy of the present types of pumping engines may be increased about 10 per cent, due to the use of higher pressure, superheating, and the utilisation of the heat in waste gases; and that within that time there is little likelihood of either the steam turbine or the gas engine superseding the reciprocating steam engine in general waterworks service.

A paper by Mr. Wm. M. Venable discussed the principles of design of velocity pumps, *i.e.*, centrifugal pumps, screw pumps, turbo pumps, &c., in which there is a continuous open channel from the suction to the discharge side. This does not lend itself to abstracting.

TURBINES AND WATER-WHEELS.

This paper, by Mr. G. S. Williams, Professor of Hydraulics at Cornell University, discussed the development of the American mixed-flow turbines and the construction of various designs. These turbines are distinguished by the thinness of the blades or buckets, which are usually made of steel plate pressed to form, or of thin cast iron, made and finished separately, and then cast into a hub and band. A large part of the paper was devoted to tests of turbine efficiency. As to impact wheels or jet wheels, investigations show that 85·98 per cent. is the attainable efficiency, under the most favourable conditions, with the Pelton buckets. Whatever is to be gained beyond this must be got in the bucket. Mr. Williams referred as follows to the development of American hydraulic turbines, after showing that the latest stage of their development is the re-application of the principles of the Francis and Boyden water-wheels to high heads and large powers:—

While the commercial results attained are highly satisfactory to the builders of wheels, the data of reliable tests of wheels of these types have not yet come into the possession of the writer. The fact remains, however, that, while only a few years ago Americans were forced to purchase machinery for such service abroad, the demand is now being very largely filled by American-designed and American-built wheels, some of which are giving better satisfaction to-day than their European predecessors.

STEAM TURBINES.

A paper by Mr. Francis Hodgkinson, of the Westinghouse Company, described a testing plant for the Parsons-Westinghouse turbine, and gave the figures of some tests. A 750-kilowatt turbine, with 150 lb. dry saturated steam, 28in. vacuum, and a speed of 1800 revolutions, showed from 13·97 lb. to 16·20 lb. of steam per brake horse-power hour.

PASSENGER LIFTS.

A long and detailed paper by Mr. Thomas E. Brown, an American engineer who has had large experience in the design and construction of this class of work, reviewed the lift, beginning with the water-balance lift and the vertical-cylinder hydraulic lift invented by Cyrus W. Baldwin, and introduced in New York in 1878. In 1889 came the first Otis electric lift of the drum type. The general principles of the different types of lifts, with their power, machinery, controlling apparatus, and safety devices, were all set forth, and it was stated that the installations of passenger and goods lifts in the United States during 1903 amounted to £2,400,000.

In the discussion, Mr. Homfray, of London, showed that many devices now used on American lifts were first used in England; but at the same time, English practice in lift construction is very much behind American practice.

Mr. Bryan, of St. Louis, spoke in favour of the electric lift, and claimed that it could safely be operated by current from a lighting circuit if care was taken to prevent too rapid a speed acceleration of the car.

IRRIGATION.

A valuable paper by Sir Hanbury Brown, M. Inst. C.E., late Inspector-General of Irrigation in Egypt, was on "Irrigation under British Engineers," and dealt with work in India and Egypt. It described the general conditions and methods, rather than the design or construction of individual works. During the past half-century the Government of India has spent about £30,000,000 on irrigation works, including 38 large "productive" works, 5 protective works, and 73 minor systems. These have an aggregate length of 44,000 miles of canals and distributaries. The latest of the great systems is the Chenab canal, which has cost about £2,000,000, and has irrigated 2,000,000 acres in a year. The people make direct payment for the use of water for irrigation. In Egypt, the basin and perennial systems of irrigation are both employed, and the results are of enormous importance and benefit to the country. "Much more remains to be done before Egypt is content and the Soudan developed, or the utilisation of the Nile water is complete. The soil of the Soudan is only waiting for the water of life for the seed to bear its 'hundredfold.'" Mr. Elwood Mead, Chief of Irrigation Investigations in the

* No. III. appeared November 25th.

United States Department of Agriculture, gave a paper on "Irrigation in the United States." About 10,000,000 acres are now being irrigated, all in the "arid region," except 600,000 acres in the rice fields along the Atlantic and Gulf coasts, 400,000 acres in the semi-arid region, and 6000 acres in the humid States. To reach these lands, 59,243 miles of main canals and ditches have been made, while the laterals represent many times this length in the aggregate. Many of the large systems require the establishment of great storage reservoirs in the mountains, and the Government departments have carefully studied sites for such works. By Act of 1902, the Government set aside the proceeds of the sales of public lands for the construction of canals and reservoirs by the Government, and a fund of £5,400,000 is now available.

A paper by M. Paul Levy Salvador, Engineer to the Minister of Agriculture, dealt with "Irrigation and Hydraulic Motors used in Irrigation in France." This related more to general principles and methods, but showed that in 1902 there were 57 canals, 3877 irrigating associations, and 37 companies for main irrigation canals, while 1,453,000 hectares of land were regularly irrigated. Many old dams are now again being used to develop water power for generating electricity for pumping; and in many cases windmill pumps are also used.

Mr. J. E. de Meyier, formerly Director of Public Works in the Dutch East Indies, read a lengthy paper on "Irrigation in Java," describing the system in general, and the works in the various provinces.

Mr. M. M. O'Shaughnessy also gave a paper on "Irrigation in the Hawaiian Islands," where the work has been prosecuted vigorously by private corporations owning sugar estates. Water is obtained from wells and streams, and also by driving tunnels into the lava formation at high altitudes.

PURIFICATION OF WATER.

Four papers were presented in this section on the subject of the purification of water for domestic use, one of the most interesting being that by Mr. Allen Hazen, an American engineer who has made this branch of work a specialty. The development in the United States dates practically from 1890, previous to which time a few sand filters and a number of filters using chemical coagulants, were in use. Since that year, however, a number of careful and comprehensive scientific investigations have been made, with experiments on a large scale, as to the treatment of sewage-polluted river waters. It has been proved, by experiment and actual practice, that for very turbid waters the sand filters, successfully used in Europe and on the clearer waters of the eastern part of the United States, are inadequate. This is of special importance, as many American cities have raw waters which are much more turbid than European supplies which have served as precedents in water purification. The turbidity can only be removed successfully by chemical treatment. On the other hand, sand filters have yielded the best hygienic results for the treatment of sewage-polluted but comparatively clear waters. The use of concrete groined arches for covering filters has been widely adopted, with most satisfactory results. American practice is to use a thicker sand bed and less gravel than in Europe, and there has been a great development in the apparatus for regulating the flow, handling the sand, and washing the sand. A A recent development is the use of preliminary filtration in connection with much higher rates of filtration than usually adopted; the new Philadelphia works, in fact, are designed for a rate of six million gallons per acre daily, as against the more general maximum of three million gallons. With a total urban population of 32,700,000 in the United States in 1904, 3,160,000 are supplied with filtered water; 560,000 by sand filters; and 2,600,000 by mechanical filters. Works now under construction will increase this percentage from 10 per cent. to nearly 18 per cent. The population thus supplied has been increased 70 per cent. in the past four years, and will probably be similarly increased in the next four years. The adoption of filtered water has greatly reduced the deaths from typhoid fever.

Water purification in France was treated in a short paper by M. Bechmann, chief of the Water and Sanitary Service of Paris. After a brief historical review, the Paris sand filters were described. Rapid filters—with or without chemical reagents—have not received any application worthy of notice in the municipal works of France. Small filters for dwellings and sterilisation by heat were mentioned, as well as methods of treating water for industrial purposes and boiler feed. A paper by Mr. Adolph Kemna, manager of the Antwerp Waterworks Company, discussed water purification, mainly in its relation to public health, and remarked that in Germany there is a tendency to return to the use of underground waters. The ozone treatment for sterilisation is still in the experimental stage, and experiments with chloride of lime and chloride of iron have shown good results. The paper by Mr. J. M. K. Pennink, director of the Amsterdam Water Supply, dealt mainly with the hydrological and hydro-geological conditions of the underground water supply of that city.

Mr. J. O. Handy, chief chemist of the Pittsburgh Testing Laboratory, contributed a paper on the purification of water for the production of steam, in which chemical treatment was stated to be far superior to the use of feed-water heaters, scum-catchers, or blow-off cocks. Several railways have used chemical treatment in locomotive boilers, but it is now generally recognised that the water should be treated before delivery to the engines. A number of different processes were described, and the considerations leading to the adoption of water softening by steam users were summarised as follows:—First, loss of service of locomotives or boilers, due to impossibility of satisfactory continuous operation with hard water; secondly, possibility of substantial savings in fuel and repair bills and the checking of rapid deterioration of boilers.

Mr. A. McGill, of the Canadian Pacific Railway, advocated the intermittent system of treatment with chemicals, as time is required to form a clear chemical solution. Water containing soda cannot be used without foaming. This railway has many very bad waters to deal with, and he suggested barium as the most promising chemical for the treatment of such waters, although at present there is no available supply of barium for the purpose. Mr. Leopold also favoured the intermittent system where the character of the water is variable, where the consumption is variable, where unskilled labour is employed, and where the capacity is less than 50,000 gallons daily. But the continuous system has advantages where space is limited, where the output must be pumped to the place of use, where the water is of constant character by analysis, and where the operator has some technical and chemical knowledge. The intermittent system is best adapted to industrial or factory purposes, while the continuous system is more adapted to railway locomotive supply.

SEWAGE DISPOSAL.

Sewage disposal in France was discussed in a paper by M. Bechmann, chief of the Water and Sanitary Service of Paris. The Paris sewage works and filter beds were mainly considered, and other places are using a similar system. The biological systems are promising, but as yet there are no important installations in France. A long and elaborate paper by Mr. George W. Fuller dealt with American practice. Many large cities discharge sewage into the harbours or open sea with satisfactory results, but there are many places where objectionable results have followed, due to faulty location and construction of the outlets. As to dilution in inland streams, this has long been a subject of investigation, and it is recognised that, from the point of view of the elimination of gross pollution, the self-purification of streams is an important feature. It is different, however, in regard to the infection of drinking waters. An important method of sewage purification is intermittent sand filtration, but experience shows that 1500 persons per acre are about all that ordinary beds will provide for. Chemical precipitation will ordinarily remove 50 to 55 per cent. of organic matter and 90 per cent. of suspended matter. The bacterial removal is usually 80 to 90 per cent. The limitations of the septic treatment were discussed, and the author considered that the tanks should have a capacity equal to twelve to twenty-four hours' flow at the average rate.

DISPOSAL OF MUNICIPAL REFUSE.

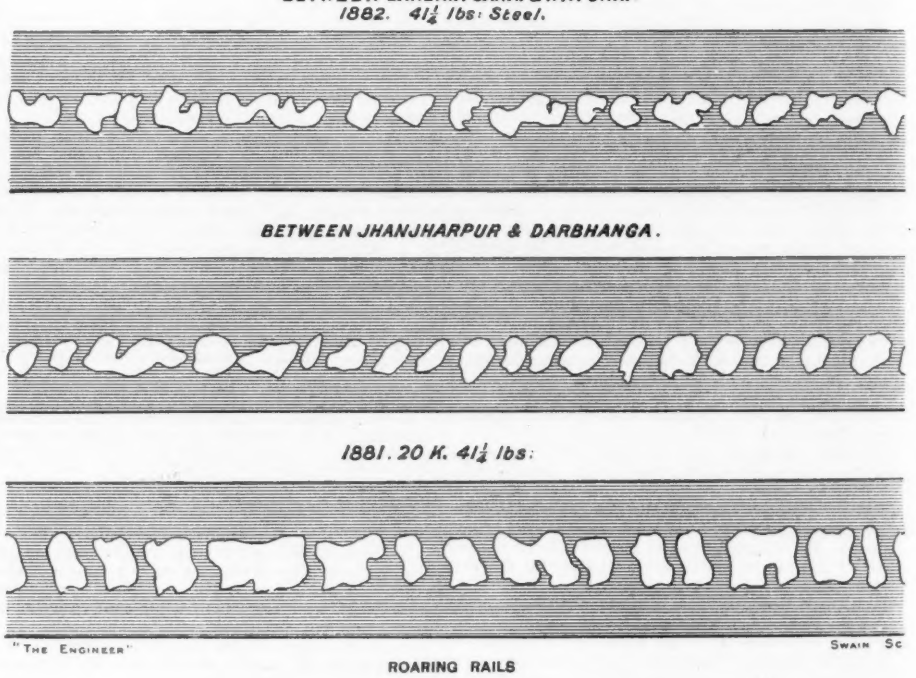
Mr. Rudolph Hering, the noted American sanitary engineer, presented a valuable paper reviewing the various methods of disposal and the results of their use, but it was shown that conditions vary so much that no system can be of general application. Careful investigations are required, such as have been carried on in Europe, to determine which processes will be the most economical for different classes of cities. The questions of utilisation of heat and the extraction of grease must also be considered, to determine whether such methods are economically practicable in view of the material to be dealt with. Mons. P. Tur, engineer of the Public Street and Lighting Service of Paris, described the collection and disposal systems of that city. Street sweepings are swept and washed into the sewers, but in most other French cities they are carried away by the wagons which collect house refuse. House refuse in Paris is kept in pails and thrown into large wagons, but this service is unsatisfactory. The garbage was originally carted to the farmers, but chemical fertilisers are so cheap that farmers do not care to be troubled with garbage. Incineration has been tried, and a peculiar feature is the use of mills for grinding the garbage, the product resembling vegetable earth and having very little odour.

Mr. Landreth, in the course of the discussion, stated that in America the separation of refuse before collection is necessary for successful disposal under any system. Ordinarily there are three classes:—(1) Garbage, or "swill;" (2) combustible material, paper, rags, ashes, and wood refuse; (3) incombustible material, old metal, glass, crockery, tin cans, &c. The garbage or swill contains about 80 per cent. water, 10 per cent. ash, and only 10 per cent. combustible material; under these conditions it is necessary to add fuel to burn or cremate effectively this material.

ROARING RAILS.

By H. L. WILKINSON, Resident Engineer, Bengal and North-Western Railway Company.

READERS of THE ENGINEER may be interested in a brief account of an investigation which I have recently conducted as to the cause of a mysterious complaint which attacks steel rails on many railways out here, causing the rail surface to be worn, under the action of traffic, into a series of ridges and valleys or corrugations, perceptible to the eye and touch, which produce a deafening noise as the train passes over them. These peculiar rails seem to be mostly confined to the Tirhoot State Railway and Eastern Bengal State Railway, though they have also been found on other Indian lines. On the former line, of which I am in charge as resident engineer, there are about 150 miles of line, out of a total of 340, in which the rails have developed this "roaring" more or less badly. The number of "roarers" varies from 15 per cent. to 90 per cent. of rails in the track, the highest percentage being in a certain make of rails manufactured in the years 1880 to 1883. There are eight or ten other dates and makes, all of which exhibit various degrees of roaring. In fact, it is impossible to



ROARING RAILS

show that the defect is confined to any particular date or maker.

The illustration shows three samples of marks on the surface of roaring rails, and is reproduced from a tracing taken by myself by means of a piece of transparent paper and pencil. The uncoloured, irregular-shaped figures represent the ridges of the surface of the rail. They appear to the eye as a row of bright polished patches, the rest of the rail surface being dull, showing that the wheel runs over these ridges, and does not touch the rest of the surface. Examination by the hand shows that the bright patches are really raised portions of the surface, with valleys in between. In some cases they stretch across nearly the whole width of the rail table, and appear as corrugations, but in the majority of cases they are as shown in the tracing, just raised lumps on the general surface. The height of these ridges, or, as some call it, the depth of the corrugations, has been measured, and found to average about 0·0035in.

An important fact in connection with these rails, which has thrown considerable obscurity over the whole question, is that they are practically confined to a road ballasted with broken brick ballast. Also that they are worse on wooden sleepers than on steel or iron ones. Some engineers have hastily concluded from this that the cause lies in the use of brick ballast, quite forgetting that there are hundreds of miles of brick ballasted lines laid with steel rails and wooden sleepers, where roaring is unknown. It has been proved, however, that roaring rails wear absolutely smooth when taken out of a brick ballasted road and laid in a road boxed with earth, or even when left alone in the track, and all the top brick ballast removed and replaced by earth boxed up to rail level, without touching the brick ballast under the sleepers.

These experiments are certainly interesting, but they are liable to throw one on a false scent, as it is hopeless to look for the cause of the defect in any quality of the ballast; and, personally, I am convinced it has to do

with some condition or quality in the steel of the rails.

It has also been found that the steel of the "ridges," or raised portions of the rail surface, cannot be scratched with a penknife or file, whereas the metal in between can be scratched easily. It has been concluded from this that the rail is laminated transversely with hard and soft metal alternately.

To settle this matter I took up some roaring rails, and tested them for hardness by the method indicated in Professor J. B. Johnson's "The Materials of Construction," pages 381 to 383, a method which has been recommended for use by the Government of India for testing the hardness of steel. It consists in dropping a given weight from a given height on to a steel punch of a certain peculiar wedge shape, and noting the length of the indentation produced in millimetres, from which, by applying a formula including the weight of the falling body in kilogrammes and the height of fall in millimetres, the degree of hardness can be calculated in kilogramme-millimetre units. Adopting this method, I found that there was practically no difference in hardness between the steel of the ridges and valleys respectively, so that the penknife and file test was illusive, and merely indicated a difference of hardness of the outer skin, caused by the wheels of the vehicles bearing on the ridges only.

I, however, made an important discovery when testing non-roaring or normal rails, and comparing the tests with those of roaring rails. I found that the roaring rails were in every case quite abnormally hard, some four or five times as hard as the non-roarers. And this was specially noticeable in comparing a roaring rail and a non-roaring rail taken from the same portion of the track and belonging to the same make and date. For instance, a roaring rail and a smooth rail, both of the same make and date, and laid near each other in the same track, were tested for hardness, and gave the following results :—

Roaring rail.	K.M. units.
Average of twelve tests on head	1483
Average of six tests on web...	830
Smooth rail.	
Average of twelve tests on head	1142
Average of six tests on web...	460

Another roaring rail, which I sliced longitudinally down the middle and tested on the exposed surface, showed enormously high average hardness, varying from 1142 units down in the web to 3854 units in the head. The degree of hardness given for medium steel—for cannons—hardened in oil, in a list printed in Professor Johnson's book above mentioned, is 455 kilo-millimetre units, which is little different from the tests shown by the webs of normal smooth rails.

This shows the enormous relative hardness of the steel of the roaring rails. When with this is taken the fact, generally admitted, that not a single case of "roaring" has ever been found among iron rails, it seems pretty plain that, whatever the theory of the peculiar row of raised patches may be, the phenomenon is due to or dependent on excessive hardness of the steel of the rail, combined with the effect of passage of the rolling stock. Probably the hard rail is thrown into more intense and rapid vibration than the soft rail, the effect being enhanced by a resonant track, and the row of symmetrically disposed and similar shaped ridges on the surface is in some way an effect of this vibration. The question is, granting that the mischief is really due to hardness, how are rails of this abnormal hardness produced?

As regards chemical composition, these roaring rails have been sent home and analysed, and it is stated that their chemical composition is quite normal. Recently, two roaring rails and one normal rail from the Eastern Bengal State Railway were sent to Cooper's Hill Laboratory and analysed, and the results published by the analyst are as follows :—

	Roaring rail.	Roaring rail.	Normal rail.
Carbon	0·691	0·472	0·459
Silicon...	0·148	0·052	0·569
Sulphur	0·067	0·124	0·076
Phosphorus ...	0·078	0·100	0·058
Manganese... ...	2·090	1·050	0·950

The analyst at Cooper's Hill concluded from these figures that there was nothing abnormal in the composition of the roaring rails except, possibly, an excess of manganese.

I understand that roaring rails are not unknown in England, but are removed from the track as soon as discovered, and that it is believed that they are manufactured from one particular ore, the "East Coast hematite," which produces an excessively hard rail, the hardness being the result of a slight excess of sulphur and phosphorus. If so, it not only bears out my own conclusions, but is also supported to a certain extent by the Cooper's Hill analysis, which shows an excess of phosphorus in the roaring rails.

To conclude, my inquiry into this problem has led me to attribute the production of roaring rails to one original cause only—excessive hardness of the steel. This sets up intense and undue vibration in the rail under the action of traffic, which is enhanced when the track has resonant properties. The nature of this vibration is that a row of "nodes," or "nodal surfaces," is produced along the table of the rail, on which the wheel runs, while the rest of the rail surface is untouched by the wheel, and consequently rusts away. Consequently, these "nodes" become eventually a row of ridges of steel raised above the general level, the rail being so hard that there is no perceptible wear on the ridges.

This may not be the true or the whole explanation; but, be this as it may, one thing is certain—that "roaring" rails are very much harder than ordinary rails. I have proved this by a large number of experiments, many within the last few weeks, and they have confirmed this conclusion without a single exception.

It is reasonable, therefore, to look upon this excessive hardness as the chief cause of the defect. This narrows the inquiry, since it only remains to consider what it is that causes the hardness. I feel convinced that it will be found to be an excess of one or two of the elements of phosphorus, sulphur, or manganese in the steel.

LITERATURE.

Les Flottes de Combat en 1904. By Commandant le Marquis de BALINCOURT. Paris: Libraire Militaire. Berger, Levrault et Cie.

IN the preface of his now well-known work the Marquis tells us that it is not a new book, not even a new edition. Having produced his last edition, he went to Cochin China, happy in the belief that he had left behind him enough *Flottes de Combat* to last the world till his return to civilisation. Then came the war, and "it appeared that people demanded *Flottes de Combats* at all costs." So a reprint, corrected to date, has been issued. The war, says the Marquis in his preface, has up to now taught us nothing new. We have seen that "battleships, cruisers, and all ships are equal before the brutal explosion of a torpedo." Consequently, people are asking whether it is wise to put so many eggs in one basket, "thirty million or more, exposed to the little capsule of a detonator." Battleships, he goes on to say, have not been shown useless against forts. It is true that they have kept far away, but it is permissible to suppose that they have secured good results. This theory hardly walks with such information as we ourselves have received: the makers of ammunition appearing to be the only people benefited by Togo's bombardment so far. Several ships that have "grounded," have, in the author's opinion, grounded upon mines, not rocks; but, on the whole, we can as yet draw no lesson, and believe little of what we have been told. The Japanese have, perhaps, concealed losses: the freedom with which the Russians have proclaimed theirs has been a methodical madness.

Thus far the preface. The pages that follow are, as usual, devoted to the fleets of the world, each nation preceded by a page of notes as before. The now classical statement about the Danes and their honest bravery which makes their little fleet respected, and even feared, remains, but this does not prevent us from turning to read what the author has to say of France.

He finds himself "embarrassed" to speak of the French navy, which any officer serving under M. Pelletan may well be. Wisely, therefore, there is no mention of that perhaps erratic, and certainly much abused Minister of Marine. "French construction," says the Marquis, "has been much decried, and this has been a great wrong." With justifiable pride he points to France as the home of the first war steamer, the Napoleon; the first floating battery, the Devastation; the first battleship, La Gloire; the first cellular protected cruiser, the Sfax; the first triple-screw cruiser, the Dupuy de Lôme. The whole world has followed. Unhappily, excellent theory has not always been marked by a corresponding excellence of practice. There are excuses. France must have a big army, and as a maritime and colonial Power she must have a formidable fleet. In the turmoil of this two-edged strife France has naturally been difficult to cater for. Standard types are now, however, coming in; battleships of 15,000 tons, with all guns in turrets, and thin side armour above the thick belts. Armoured cruisers growing to 18,000 tons seem destined to become the pivot of naval strategy. Protected cruisers are ceasing to be worth consideration.

In the pages that follow the Iéna is credited with far more armour than corresponding British works give her, for instead of being like the Charlemagne class, she is plated like the Mikasa or Wittelsbach. The Renan, Michelet, and Edgar Quinet are all classed together as six-funnelled Gambettas, with eight little turrets carrying one 6·4in. each, instead of the six pairs and casemates, as in the Gambetta. Since this was published, of course, the plan of the Edgar Quinet has been changed, and she will more closely resemble the Suffren in the disposition of her 6·4in. guns.

In submarines there is a very good feature. Just as we have been trained to speak of Holland, or Lake boats, so here the many French craft are sorted out to the three great submarine inventors—Lauboeuf, the creator of "submersibles," Romazzotti, and Mangas.

The prime features of interest in *Flottes de Combat* are the author's "observations" upon the different types. Turning to new ships, we find that in connection with the Braunschweig he considers the German trend to be increased displacements and less speed, this being sacrificed for protection to the secondary guns.

The King Edward is pointed to as an example of how we have at last taken to the complete belt. The Black Prince type is "comparable to the most recent American." The most recent Americans are described as the most powerful armoured cruisers in the world. The famous Bayan is put down as "one of the most successful cruisers afloat or in construction." Certainly there is no ship that has survived being "sunk" so often during the war. Thanks to the unusually thick belt—8in. instead of the orthodox 6in.—the Bayan's vitals are in less danger than those of many battleships, though curiously enough she has been the only ship to be hit there.

In his preliminary notes both to Russia and Japan the author waxes prophetic. In Russia, he draws attention to the hare and the tortoise fable; while in Japan, discussing the Kashimas, he wonders whether they will not be obsolete by the time the war is finished.

SHORT NOTICES.

Mechanical Railway Signalling. By H. Raynor Wilson. London: Railway Engineers, 3, Ludgate Circus-buildings, E.C. Price 18s. net complete, or in four parts 5s. each.—The subject of mechanical railway signalling is receiving so much attention at the present time that this book comes as a welcome addition to the literature already written on this subject. The details of the various mechanisms are carefully described, and the accompanying illustrations are excellent. The book is divided into eleven chapters, the first one being an introduction, in which is given a general idea of signals. Following this is given a short history of the methods of working a single line. Other chapters are written on signal-boxes, signals, signal and point connections, locking frames, level crossing gates, large signalling installations, and Board of Trade requirements. The plates showing the arrangements for signalling at Waverley Station, Edinburgh, the North-Eastern Station at Newcastle-on-Tyne, and Waterloo Station, London, and Liverpool-street, are of particular interest. To all concerned with mechanical signalling this book should prove most instructive.

The Design of Plate Girders.—By W. E. Lilley, M.A., M. Inst. Mech. E. London: Chapman and Hall, Limited. Price 7s. 6d.—In this small work the author has considered the subject very carefully from a theoretical point of view. He commences by making a few remarks on the strength of iron and steel, and includes equations for getting the working strength of steel and iron, adopting three in one case and five in another for the factor of safety, and 30 tons per square inch and 22·8 tons per square inch for steel and iron respectively. The diagrammatical methods of obtaining the bending moments and shearing forces are then given in the next chapter; the numerous illustrations make the reading matter quite clear. Then, after a few words on the theory of bending and distribution of stress, and the strength of materials under compound strains, the author discusses the design of plate girders. This section includes interesting articles on standard types of superstructure, weight of plate-girder bridges, and many useful and instructive tables.

Portland Cement for Users. By D. B. Butler. London: Crosby Lockwood and Sons. Price 3s.—In a few pages that the authors have devoted to this subject will be found much valuable information about cement. The book has been written in a systematic manner, and in expression it is clear. In the first few chapters weight, fineness, gauging, and setting are dealt with. Then follows a brief description of testing, but one or two important tests have been omitted. Those that are mentioned consist of the tensile and sand tests. The chapters on the application and adulteration of cement are also interesting. A supplementary chapter has been written by the late Henry Faija, and in the appendix is given a considerable amount of useful information concerning, principally, the properties of cement.

Fowler's Electrical Engineers' Year-book and Directory of Light, Power, and Traction Stations, 1905. The Scientific Publishing Company, 33, New Bailey, Manchester. Price 1s. 6d.—This useful pocket-book has been brought up to date, and has been re-written and revised. Many new tables and other useful data have been included in this edition, especially in those parts which deal with secondary batteries and lighting. The directory of electric light and power stations is a special feature of the book, and is sure to be greatly appreciated by engineers. Another useful section which has been added includes the recommendations of the British Standards Committee for generators and motors.

The Practical Engineer's Pocket-book, 1905. The Technical Publishing Company, Limited, 287, Deansgate, Manchester. Price 1s.—We have just received the 1905 edition of this pocket-book, and find it quite up to its usual standard, whilst much new information has been added. The rules for the installation of electric motors and dynamos issued by the Associated Fire Offices Committee, and also the wiring rules of the Institution of Electrical Engineers, will be found useful. The new patent regulations, which come into operation next year, have been included in this edition.

Untechnical Addresses on Technical Subjects. By James Douglas, LL.D. London: Chapman and Hall, Limited.—The author has divided his small book into three chapters under the following titles:—"The Characteristics and Conditions of the Technical Progress of the Nineteenth Century," "The Development of American Mining and Metallurgy, and the Equipments of a Training-school," and, lastly, "Wastes in Mining and Metallurgy." Each one of the chapters is an address given by the author before different societies in America.

The Practical Engineer's Pocket-book. 1905. London: Simpkin, Marshall and Co., Limited. Price 1s.—This pocket-book contains a great deal of information within its 583 pages, and much has been added since the last edition. Special attention has been paid to the revision of those sections dealing with turbines, and transmission of power by means of rope-driving, much information being added that greatly increases their value.

BOOKS RECEIVED.

River, Road, and Rail. By Francis Fox. London: John Murray. Price 8s.

Locomotive Operation. By G. R. Henderson. Chicago: *The Railway Age,* 1904.

Metal Working. By Paul W. Hasluck. London: Cassell and Co., Limited. Price 9s.

Model Steam Turbines. By H. H. Harrison. London: Percival Marshall and Co. Price 6d.

Annual Report of the Commissioners of Patents for 1903. Washington: Government Printing Office.

A Handbook of Chemical Engineering, Vols. I. and II. By George E. Davis. Manchester: Davis Brothers.

Annals of Coal Mining and the Coal Trade. By Robert L. Galloway. London: The *Colliery Guardian* Company, Limited.

A Record of the Baltimore Conflagration. By Edwin O. Sachs, F.R.S.E. London: The British Fire Prevention Committee. Price 5s.

Directory and Statistics of Electric Lighting and Traction Works. By C. S. Vesey Brown. London: Hazell, Watson, and Viney, Limited. Price 10s. 6d.

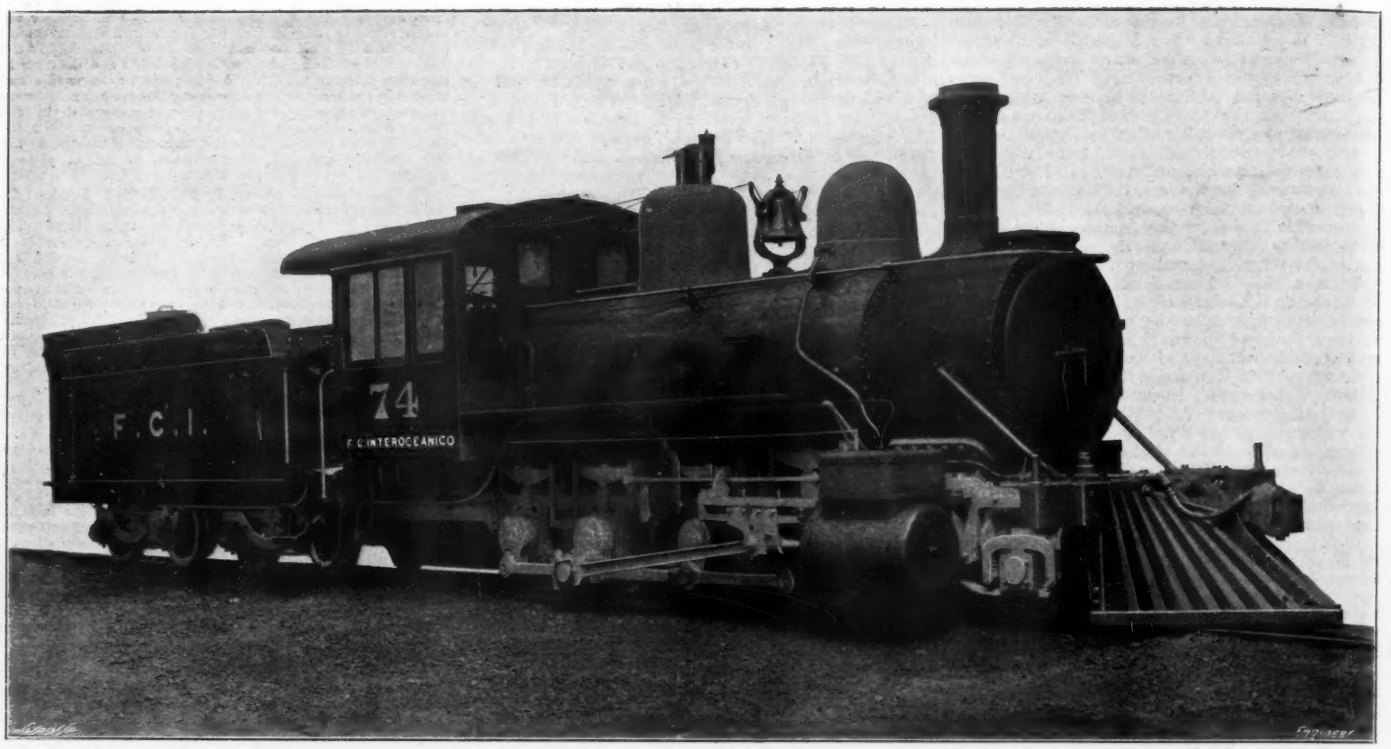
Proceedings of the Thirty-seventh Annual Convention of the American Institution of Architects. By Glenn Brown. Washington: D. C. Gibson Brothers.

B. G. Teubner's Sammlung von Lehrbüchern auf dem gebiete der Mathematischen Wissenschaften mit Einschluss ihrer Anwendungen. Band XI. The Dynamics of Particles, and of Rigid, Elastic, and Fluid Bodies; being Lectures on Mathematical Physics. By Arthur Gordon Webster, A.B. (Harv.), Ph.D. (Berl.), Professor of Physics, Clark University, Worcester, Mass. Leipzig: B. G. Teubner, 1904.

ELECTRIC DRIVING IN COTTON MILLS.—We understand that Messrs. Mather and Platt, Limited, have recently settled an important contract for the plant required for the electric driving of two cotton mills in Spain, which will be one of the largest and most complete installations of the kind. The well-known spinning and weaving mills, with adjoining dye and hosiery works at Malaga, in Andalusia, belong to the Marquess of Larios, who was a pioneer in starting Spanish manufactures, and are the largest in the country, employing about 5000 hands. Arrangements have lately been made by the Marquess for obtaining a supply of electric power from the Chorro Power Company, which has established a generating station in the celebrated Chorro gorge, some fifty miles north of Malaga. The power is transmitted by three-phase current at a pressure of 25,000 volts to a sub-station in Malaga, where the pressure is reduced to 2500 volts, part of the energy being supplied to the Malaga electric lighting station. The contract includes the underground cables from the Malaga sub-station to the two mills "La Aurora" and "La Industria," which are at a distance of about half a mile. A secondary receiving station is to be placed at each mill containing three-phase transformers for reducing the pressure from 2500 to 400 volts for supplying the three-phase motors, which will be employed universally throughout the mills, the steam plant being entirely discarded. There will be seventy-two motors, varying in power from 3 horse-power to 150 horse-power, and aggregating 2500 horse-power. The Larios Company anticipates that by the use of electricity in place of steam it will save considerably more than 20 per cent. of the yearly cost of power.

NARROW GAUGE LOCOMOTIVE, MEXICAN RAILWAYS

KERR, STUART AND CO., LIMITED, STOKE, ENGINEERS



NARROW-GAUGE CONSOLIDATION LOCOMOTIVE.

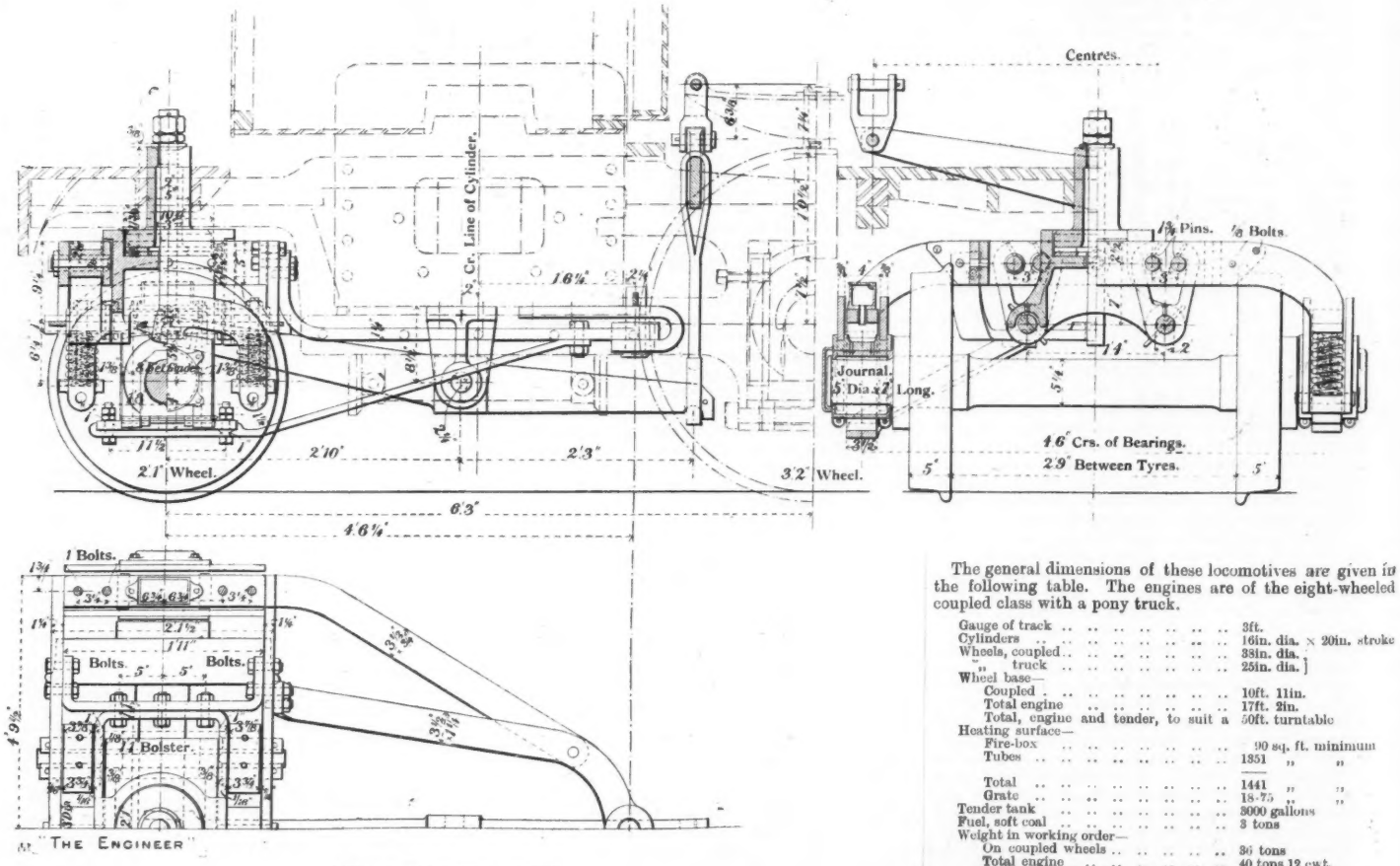
OUR Supplement this week illustrates certain very powerful locomotives constructed for the Mexican, Eastern, and the Interoceanic Railways, by Kerr, Stuart and Co., Limited, Stoke. Particular attention may well be given to the compensating gear, which takes in even the Bissel pony in a strikingly original manner.

The boiler pressure is 180 lb., the shell is $\frac{9}{16}$in. thick, the outer fire-box $\frac{1}{2}$in., and the largest diameter is 56in. The fire-box is of acid open-hearth steel, with a $\frac{3}{8}$in. crown sheet, a $\frac{1}{2}$in. tube sheet, side sheets $\frac{5}{16}$in., and back sheet $\frac{3}{8}$in. The stay bolts are of best Yorkshire iron 1in. and $\frac{7}{8}$in. diameter, 4in. centres. The tubes are of genuine Swedish charcoal steel, No. 12 B.W.G., 179 in number, 2in. diameter and 14ft. 6in. long, set with copper ferrules at the back end and beaded over in the fire-box. The bar frames are of peculiar construction. They are outside the wheels, and $3\frac{1}{2}$in. thick. The main frame is in one section from the front of the fire-box to the back of the cylinders. The forward section is securely bolted and keyed to the main frame.

There are slab frames at the sides of the fire-box, separate pieces from the main frame, and bolted thereto by means of eight turned and countersunk bolts, $1\frac{1}{4}$in. in diameter. This arrangement is to provide for the removal of the slab frames, so as to facilitate the renewal of stay bolts in the sides of the fire-box without dismounting the entire main frame or lifting the boiler. The pedestals are protected from wear by bronze shoes and wedges, and locked together at the bottom by a bolt through a cast iron thimble. The slab frames on either side of the fire-box are 9in. deep by $1\frac{3}{4}$in. thick. The dimensions of other parts will be obtained from the drawing.

The tender is carried on two four-wheeled trucks, the wheels are 31in. in diameter, the frames are of 8in. channel iron, the tank holds 3000 gallons, and the bunker three tons of coal.

The order for five engines was given at the end of January. Two were under steam in June, and three in July. As all patterns had to be made and material obtained, it will be seen that the execution was prompt. The workmanship and material of these engines will maintain the high reputation of the firm. We may add that Messrs. Livesey, Son and Henderson were the inspecting engineers.



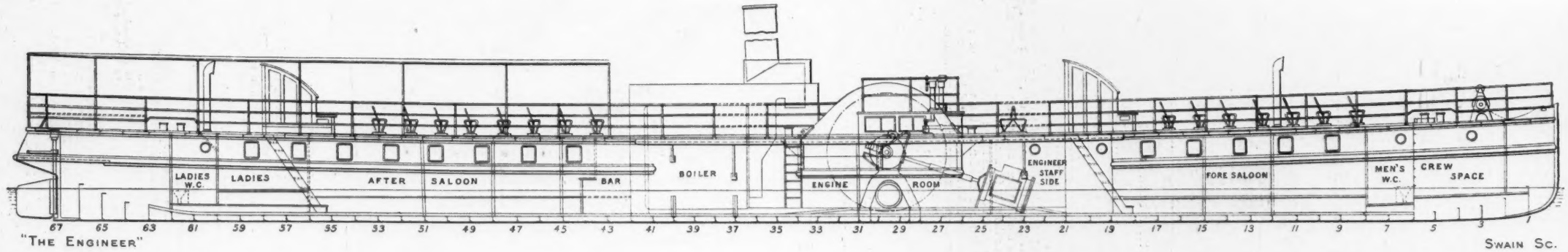
DETAILS OF BISSEL TRUCK

The general dimensions of these locomotives are given in the following table. The engines are of the eight-wheeled coupled class with a pony truck.

Gauge of track	3ft.
Cylinders	16in. dia. × 20in. stroke
Wheels, coupled	33in. dia.
,, truck	25in. dia.
Wheel base—	
Coupled	10ft. 11in.
Total engine	17ft. 2in.
Total, engine and tender, to suit a	50ft. turntable
Heating surface—	
Fire-box	90 sq. ft. minimum
Tubes	1351 ,, ,,
Total	1441 ,, ,,
Grate	18·75 ,, ,,
Tender tank	3000 gallons
Fuel, soft coal	3 tons
Weight in working order—	
On coupled wheels	36 tons
Total engine	40 tons 12 cwt.
Total tender, loaded	28 tons.
Weight on any axle not to exceed	21,000 lb.
Curves, minimum	250ft.
Tractive power, cutting off at ¾ stroke with full boiler pressure =	21,558 lb.

THE Metropolitan District Railway Company will apply for an Act to empower it to use for the general purposes of its undertaking, including the cost of adapting the railway to electrical working and of improving and widening it, part of the capital authorised by the Act of 1897; and to define, capitalise, or otherwise deal with the arrears of dividend or interest upon its guaranteed stocks.

PROPOSED THAMES PASSENGER STEAMERS


LADIES W.C.
LADIES
AFTER SALOON
BAR
BOILER
ENGINE ROOM
ENGINEER STAFF SIDE
FORE SALOON
MEN'S W.C.
CREW SPACE
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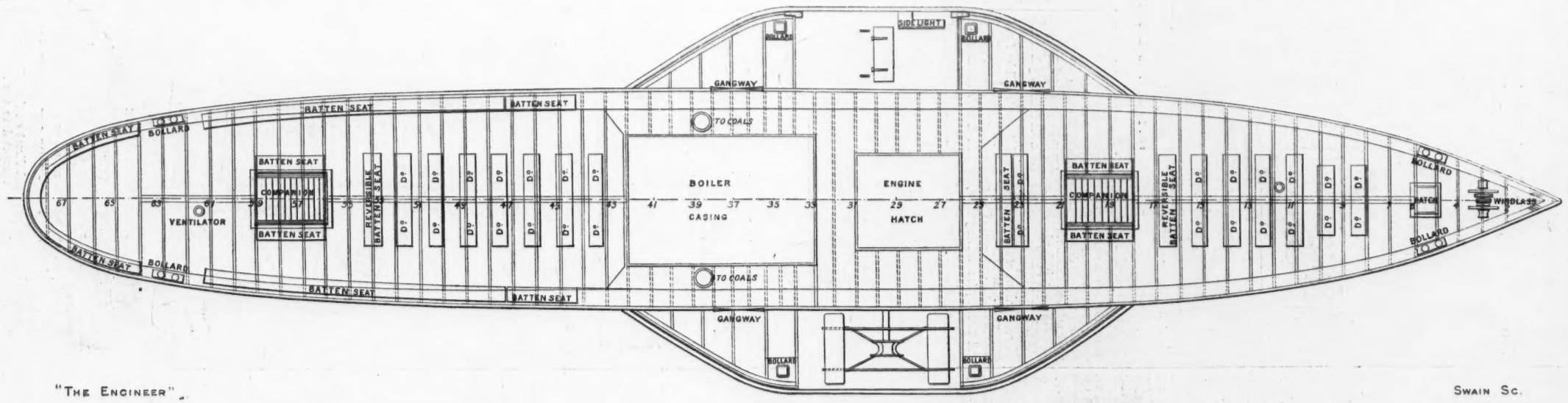
"THE ENGINEER" SWAIN SC.



"THE ENGINEER" SWAIN SC.

THE NEW THAMES PASSENGER STEAMERS.

THOSE of our readers interested in the establishment of an efficient passenger steamboat service on the Thames river will remember that in THE ENGINEER of August 24th, 1900, in an article, the first of a short series on the "Thames Passenger Steamboat Service," we recorded the fact that in late issues of that journal attention had been directed to the particulars of a scheme which the London County Council had formulated for establishing a service of passenger steamers on the Thames; and an opinion had been offered as to the conditions that should obtain to give any such service a chance of success.

The proposal to establish such a service was then, as now, no news to our readers, seeing that many of them in their time had witnessed several such attempts, most of which in the sequel, however, had failed of success, and resulted as at present in leaving the river without what could by any fiction be called a passenger steamboat service. A spasmodic attempt, we admit, was made in 1897 after all others had failed to establish such a service, by what has been known as the Thames Steamboat Company, which took over the old, out-of-date, and practically worn-out boats of the then defunct Victoria Steamboat Association, but adding to them three new boats specially built by the Thames Ironworks Company at Blackwall, to afford better accommodation for the river passenger traffic than those previously in use.

All three of these vessels were of the same dimensions, the first one completed, and named the Alexandra, being 120ft. long between perpendiculars, 17ft. beam, 7ft. 6in. moulded depth, and drew when light 2ft. 6in. of water. She was very shortly followed by her sister vessels, the Boadicea and Cleopatra, but their advent did not much improve the passenger service on the river, and as this service was practically closed to the travelling public for at least seven months in the year, it soon became an experience to the Thames Steamboat Company, as to its predecessors, that its passenger traffic did not pay its expenses, and, as a consequence, brought about the discontinuance of the service, the result of the attempt to establish it justifying the conclusion arrived at by us, and stated in an article on this same service in our issue of February 22nd, 1901, viz., that the task of starting and maintaining such a service as would meet all requirements is beyond the capacity of private enterprise, and that such an undertaking is probably only possible if carried through by some great central authority such as the London County Council.

Since the discontinuance of the service by the Thames Steamboat Company, the question of a passenger steamboat service on the river has been frequently mooted and as often discussed but in a somewhat perfunctory manner by the London County Council, without any unanimous decision as to the necessity for such a service, until within the last six months, during which time it has been decided that such a service shall be established, the boats employed in it to run between Hammersmith and Greenwich.

Consequent on this decision, it was agreed by the Council to invite a tender for the construction of the proposed fleet of steamers, which was to be thirty in number, the proposed design of the boats to accompany the tender for their construction.

So far as the type of boat for the intended service was concerned, the London County Council, after the fullest consideration of all the conditions under which that service was to be carried on, concluded that the best kind of boat would be that propelled by paddle-wheels; the Thames river service being peculiar, in that its tide, which rises and falls twice daily as much as 18ft., limits the height above water of any part of the boat's structure or fittings, such as stanchions, awnings, &c., to 12ft. 6in.; the numerous bridges that have to be passed on the Hammersmith service would be fouled at high water, and as the tide recedes so much at low water, the boats would be in danger of getting aground if drawing more than 2ft. 10in. to 3ft. As far as their speed is concerned, the frequent stoppages caused by the crowded state of the river precludes a high engine power being employed, and the limited draught of water, together with the stringency of the Thames Conservancy laws as to "steamers' wash," had to be considered in deciding on the design and dimensions of the vessels.

Taking the foregoing considerations into account, the London County Council on the 27th of July of the present year invited the Thames Ironworks Company to tender for the construction and fittings of thirty steamers, or any lesser number as low as ten, as they could not accept a variety of designs. This company could lay down and build in its shipyard as many as twenty hulls of such vessels, and construct all the engines for the whole fleet at the Greenwich engine works; so prepared a design to fulfil the requirements of the Council, which were as follows:—Length not to exceed 140ft., but less preferred; breadth to be left to the builders; depth moulded, 7ft.; draught of water not to exceed 2ft. 10in., with 40 tons weight on board, representing passengers, coals, crew, &c. The speed with this load on a three hours' trial to be 13 miles an hour, or a 12 miles' working speed when on service. The engines to ensure this speed—under onerous penalties—to be of the compound surface-condensing type, their power being left to their builders to determine.

To meet these conditions the following dimensions, &c., were proposed by the Thames Ironworks Company:—Length, 130ft.; beam, 20ft.; depth, 7ft.; draught, 2ft. 10in.; horse-power of engines,

270. Having prepared a design and specification to these particulars, inquiries were made of five firms by the Ironworks Company if they would undertake to build to its design and specification and submit tenders to it, the company taking the responsibility of the design. To this all the firms applied to agreed, each being able to build four or five vessels at a price which enabled the Ironworks Company to submit a tender for the whole fleet on the 26th of September at the price of £7000 each.

A smaller type of vessel, however, being considered more suitable and less costly by the tenderers, an alternative design was submitted to the London County Council. On the 6th of October, however, a letter was received from the Council stating that as considerable difficulty had been found in deciding the merits of the various designs sent in, the best way would be to forward a revised tender for an alternative design embracing all the principal features thought desirable. A revised plan and tender was accordingly sent in by the 12th of October, the particulars of which were as follows:—Length of vessel, 130ft; breadth, 18ft.; depth, 7ft.; draught, 2ft. 10in. with 25 tons deadweight, instead of 40 tons on board. The penalties as to realised speed on trial, draught of water, and conditions as to rates of wages to all classes of mechanics, labourers, &c., employed in the work to be as before.

The design of the vessel had also to be submitted to Lloyd's Register, and as a consequence several tons of unnecessary weight has been introduced in it beyond what has been found to be required in such vessels employed in the previous passenger steamboats engaged in similar services on the Thames.

On page 541 we give a profile and plan of the vessels as approved by the London County Council for the proposed Thames passenger service, the dimensions of which have just been given. It shows the arrangement of seating on deck, and the extent of saloon space below, for the accommodation of passengers. The construction of the fleet of thirty boats has been divided between three firms, viz.: The Thames Ironworks Company, of Blackwall; Messrs. J. I. Thornycroft and Co., of Chiswick; and Messrs. Napier, Miller and Co., on the Clyde; each of which will build ten hulls, the first-named firm contracting to build both the hulls and engines, and the last-mentioned twenty sets of machinery in addition to the ten hulls.

So far as the boats to be built on the Thames at Blackwall are concerned, the work is already being rapidly pushed on. The steel material for both hulls and engines is coming to hand. The deck planking is cut and seasoning, but it is not thought possible, under present weather conditions especially, that the fleet can be got ready for its intended service by May 1st of next year as intended.

At the last meeting of the London County Council it was agreed that Professor Biles should be retained, at a fee of £750, for the purpose of supervising the construction of the hulls of these boats, such amount to cover his fees for all assistance rendered to the Council since the passing of the Thames Steamboat Service Act, and any future work which it may be necessary for him to do for the Council during the construction of the boats. The Committee also asked for power to employ three inspectors at a salary of £4 a week for a period of six months in connection with the construction of the boats.

In a later issue we shall describe and illustrate the propelling engines, &c., intended to be fitted in these new passenger river steamers.

AN ARMOURED MOTOR TRACTOR.

A DEMONSTRATION was given last week in Millbank Barrack-square, which was of some interest from a military point of view. Its object was chiefly to show the applicability of the Ivel agricultural motor tractor to field operations, and with this object the vehicle—which is familiar to our readers—was, with the exception of the driving wheels, encased in bullet-proof steel shields of Major Palliser's design, made by Messrs. Cammell, Laird and Co. The arrangement of the plates is such that they can be opened out at the rear and armoured flaps let down to the ground, thus enabling ambulance work to be carried out behind them without danger from the enemy's rifle fire. The plates are ⅜in. thick, and are sufficiently tough to resist the bullets from small arms, but it was apparent that a projectile from a 9in. gun or a small shell would prove absolutely fatal to the whole machine. It was explained that the vehicle was not designed to withstand heavy fire, but it would obviously form an admirable target for it, and the question arises whether the plates ought not to be heavier. The motor is of the horizontal internal combustion type, with two cylinders, said to be capable of giving 18 horse-power, and the power is applied to the road wheels through the usual gearing and chains. The fuel used is petrol, and this must prove a drawback to motor traction on the battlefield. If explosion engines are to supply the necessary power, they must be able to utilise ordinary heavy oils of commerce, obtainable everywhere. Then, again, the ignition of the explosive charge was brought about by accumulator and coil. A more serviceable method would be a magneto system, which would obviate re-charging of batteries—a difficult matter in war.

In the course of the demonstration it was shown how by the addition of a pulley on an extension of the crank shaft, the engine could be used to drive a dynamo for lighting a hospital tent, for instance, or, when coupled to an ambulance cart, could haul a load of nearly thirty men. The experiments were carried out on level ground. In following an army in the field very different conditions would be met with, and it would seem that the motor vehicle would need to be both heavier and more powerful. The demonstration was interesting, if not entirely convincing, and will help to further hasten the general adoption of self-propelled vehicles by the War-office.

A DEVICE has been invented for notifying motor car drivers by the ringing of a bell when a pre-determined limit of speed has been reached. It consists of a tube secured to the wheel of the vehicle and carrying a sliding weight therein, normally held against the inner end of the tube by a coil spring. When the wheel is in motion, the weight is thrown outward by centrifugal action, a distance varying with the speed of the wheel. When the speed limit is reached, the weight is thrown far enough to engage and make electrical contact with a screw held in an insulating block in the outer end of the tube. This screw connects with a contact piece on the wheel which, at each revolution, engages a stationary contact on the vehicle frame. The circuit is thus completed to an electric bell.

ELECTRIC LOCOMOTIVES FOR THE NEW YORK CENTRAL AND HUDSON RIVER RAILROAD.

THE New York Central Railroad has decided to handle all its traffic within the neighbourhood of New York by electric locomotives, and for this purpose it is now making the necessary changes on the main line from the Central station to Croton, a distance of 34 miles, and on another length of 24 miles on the Harlem Division as far as White Plains. So far only one locomotive has been built, and upon its success under severe tests the design and ordering of some thirty to fifty engines will depend. This engine has been constructed by the General Electric Company, and the American Locomotive Works, both of Schenectady, and has already made a large number of experimental runs on a six-mile length of line especially equipped for the purpose.

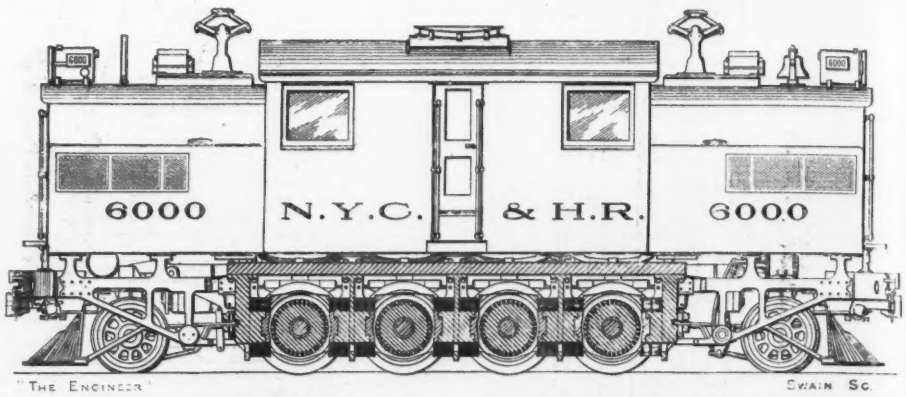


Fig. 1—ELECTRIC LOCOMOTIVE—PART SECTION

Several views of the locomotive and its parts will be found on page 545, and on this page. Fig. 1 shows a longitudinal section of the underframe and motors. The engine has, it will be seen, four driving axles, on each of which is mounted direct, that is, without gearing of any description—see Fig. 2—an electric motor having a normal rating of 550 horse-power. These motors will, of course, stand a fair overload for a short time, so that the total power of the engine, normally 2200, may rise to between 3000 and 3500, or well above anything ever attempted in a steam locomotive. The total weight is 95 tons, of which 69 tons are taken by the driving wheels, so that there will be ample power and adhesion for moving heavy trains at a good speed. The requirements are that one locomotive shall take a train of 450 tons at between 60 and 65 miles an hour, and that for heavier trains, two or more engines shall be employed, so that the same speed may be maintained even with loads of as much as 875 tons. In order to facilitate the running of trains under such conditions, the Sprague General Electric multiple-unit system of control will be employed, so that when two or more engines are coupled together, they may be operated from the leading cab as a single unit

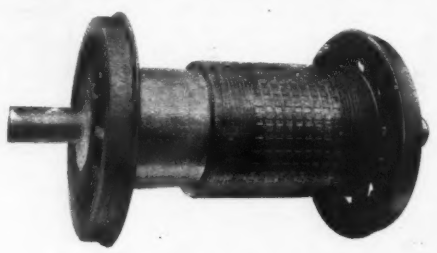


Fig. 2—ARMATURE AXLE AND WHEELS

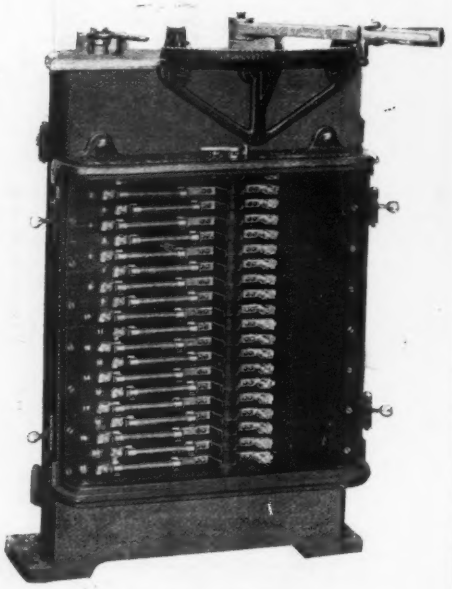


Fig. 3—CONTROLLER—BACK

The armatures being mounted direct on the axles, whilst the field magnets are rigidly connected to the frame, it is necessary to allow ample clearance between the two, so that the former may rise and fall with the movement of the springs, hence the faces of the pole-pieces are almost flat. The disadvantage of this large clearance is more than compensated, it is considered, by the reduction in the number of bearings and the general simplicity of the design. Repair and renewal are also greatly facilitated, as an armature with its wheels and axle may be removed by lowering the complete element without disturbing the fields or any other part of the locomotive, and a new element inserted in its place. The brushes, of course, have to maintain a fixed relationship to the commutator, and the holders, therefore, are mounted on insulated supports attached to the spring saddle over the axle journals. They are adjustable to compensate for wear of the commutator and axle bearings.

The main frame is a fine steel casting, some 35ft. long, and follows in its design the general idea of the "bar" frame. It forms not only the mechanical frame of the locomotive, but also part of the magnetic circuit of the motors, the two end pole pieces being cast with it, whilst the three intermediate double pieces are carried by heavy steel transoms bolted to the side frames. The field coils are wound upon metal spools, which are bolted upon the pole pieces. Proper distribution and division of the weight of the locomotive amongst the axles is accomplished by suspending the main frame and superstructure from a system of half elliptic springs and equalising levers of forged steel, the whole being so arranged as to cross-equalise the load and to furnish three points of support. The pony trucks are of the radial type, and are pivoted by means of radius bars to the end of the main frame in a similar manner to the standard construction adopted by the New York Central and Hudson River Railroad Company for its steam locomotives.

The superstructure consists of a central cab with extensions

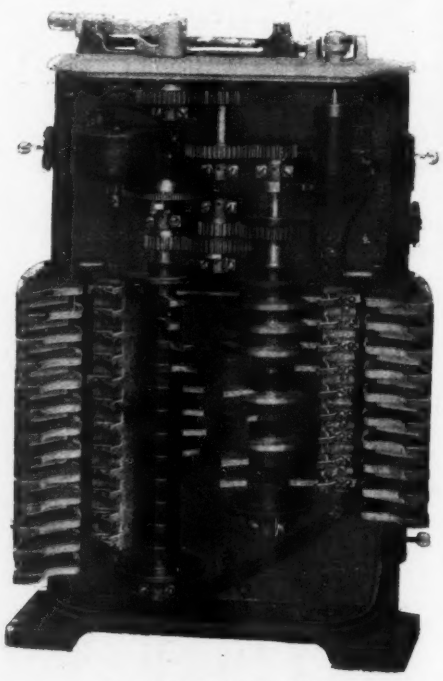


Fig. 4—CONTROLLER—FRONT

fore and aft. The driver sits facing the right-hand leading window, with the controller—Figs. 3 and 4—in front of him, the brake levers, whistle rope, &c., in convenient positions, whilst the gauges and speed indicator are placed where he can read them easily from his seat. The locomotive being intended to run in either direction, all the driver's fittings are in duplicate. The centre of the cab, occupied in the experimental engine by a table bearing the observation instruments, will in the winter receive a boiler—possibly of the Locomobile type—to generate steam for heating the train; in the summer this boiler will be removed. Air for the brake, whistles, &c., is supplied by a General Electric motor-driven compressor, having a capacity of 75 cubic feet of free air per minute. It is controlled by a governor which cuts out the motors as soon as the pressure in the reservoir exceeds 135 lb., and cuts it in again at 101b. lower. The contactors, rheostats, and reversers are arranged along the sides of the fore-and-aft extensions in boxes of sheet steel, which are sheathed on the inside with fire-proof insulating material. All of these appliances are, therefore, easily accessible for repairs or inspection. A door at each end of the superstructure permits of access to the train.

The control system permits three running connections, namely, four motors in series, two groups of two in parallel

series, and all four motors in parallel. The motor reverser, contactors, rheostats, and other controlling appliances are all of the Sprague-General Electric multiple-unit type. The master controller, however, is fitted with a special operating lever, about 24in. long, and capable of being moved through an angle of about 75 deg. It is provided with a current-limiting device, which consists of a friction clutch, operated by an electric magnet, energised by the current passing through one of the motors, the arrangement being such that when the current exceeds a pre-determined amount the cylinder cannot be rotated further until the current has fallen sufficiently to allow the relay to drop. As long as the current does not exceed the desired limit, the automatic feature is not in operation.

Current is collected from the third rail, which is placed on the outside of the track, by multiple-contact spring-actuated

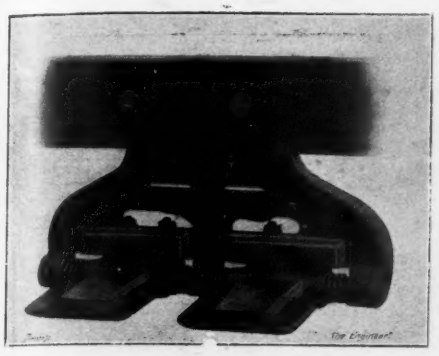


Fig. 5—THIRD RAIL SHOE

shoes—Fig. 5—whose supports are carried on channel irons attached to the journal-box. There are four of these shoes on each side of the locomotive. In the yards at the terminal the large number of switches and crossings necessitates an overhead construction in places, and additional contacts are therefore mounted on the top of the locomotive for collecting current when the locomotive is passing over these points. This device may be raised and lowered by air pressure controlled from the engineer's cab. A magnetic ribbon fuse is placed in circuit with each shoe and overhead contact device, so as to secure protection in case of accidental short circuit.

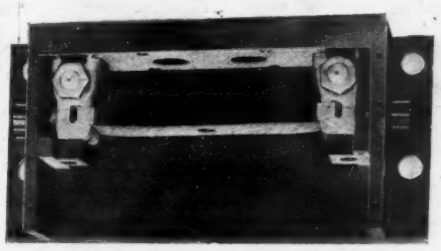


Fig. 6—1500 AMPERE FUSE BOX

Some general data and dimensions of this locomotive are given below :—

Number of driving wheels	Eight
Number of pony trucks	Two
Total weight of locomotive	95 tons
Weight on drivers	69 "
Rigid wheel base	13ft.
Total wheel base	27ft.
Length over buffer platforms	37ft.
Extreme width	10ft.
Height to top of cab	14ft. 4in.
Diameter of drivers	44in.
Diameter of pony truck wheels	36in.
Diameter of driving axles	8·5in.
Normal rated horse-power of locomotive	2200
Maximum horse-power	3000
Normal draw-bar pull	20,400 lb.
Maximum starting draw-bar pull	32,000 "
Speed with 500-ton train	60 m.p.h.
Voltage of current supply	600
Normal full load current	3050 amperes
Maximum full load current	4300 "
Number of motors	Four
Type of motor	G.E. 84A
Rating of each motor	550 h.p.

The experimental line on which this engine is being tested

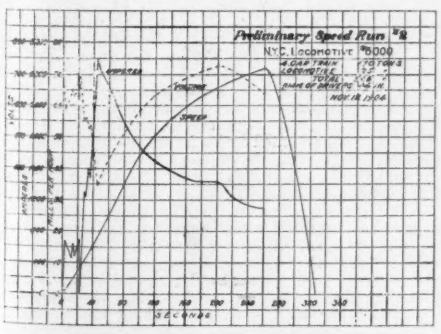


Fig. 7—ACCELERATION CURVE

is, as already stated, about six miles long. It forms part of the main line and extends from Shenectady to Hoffman, and is for the greater part straight, but at one end it makes a moderate curve; it is also practically level. The power is supplied by a Curtis turbo-generator—page 545—situated at the General Electric Company's works. It has an output of 2000 kilowatts, three-phase current, 25 cycles, at a tension of 11,000 volts. The current is transmitted to a sub-station—Fig. 8, above—at Wyatt's. It contains a 1500-kilowatt, 650-volt, 25-cycle General Electric rotary converter, with necessary static transformers for reducing the line potential from 11,000 to 460 volts, and a switchboard consisting of a 600-volt direct-current rotary converter panel, an alternating-current starting panel and a high-tension panel with electrically-operated, type H oil switch. The rotary converter is self-starting from the alternating-current end, thus requiring no synchronising or other complications when throwing machine into service. The step-down transformers are tapped to give one-third, two-third, and full voltage for starting the rotary converter, these voltages being applied successively by means of double-throw lever switches. This apparatus, the building

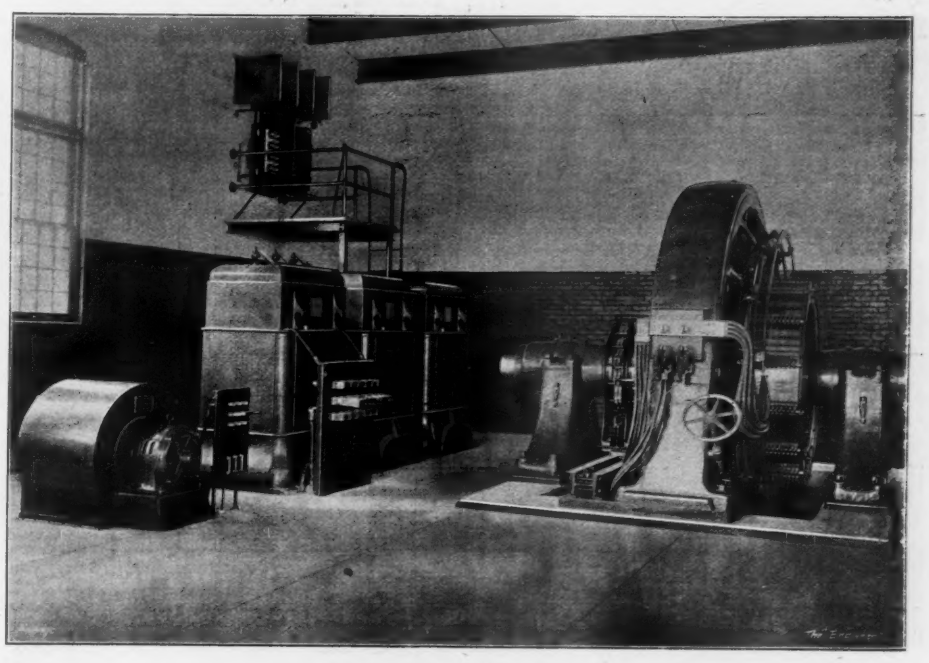


Fig. 8—INTERIOR OF SUB-STATION

and the arrangement are in general as proposed for the sub stations to be built within the electric zone at the New York city terminal, so that practical experience with the plant may be obtained while the locomotive tests are being made and in advance of construction.

The experiments are only in their initial stage, as the full length of track is not yet equipped, but a number of results have been already obtained, some graphic results of which are shown in Figs. 7 and 10, which give speed, current input, and voltage at the locomotive all on a time basis, with an eight-car train weighing 336 tons, and a four-car train weighing 170 tons, both exclusive of the locomotive. The total weight of the train, including the locomotive and passengers, was 431 tons and 265 tons for the eight-car and four-car trains respectively.

Two sets of curves are shown, two running tests reaching as high a maximum speed as possible with the length of track available, and two sets of starting tests showing the more rapid rate of acceleration possible with the higher maintained

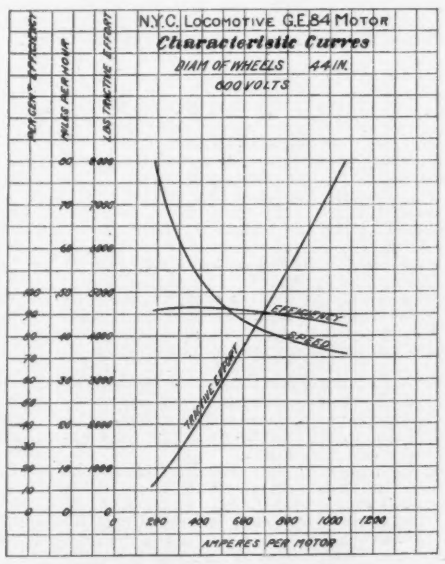


Fig. 9—EFFICIENCY, &c., CURVES

voltage available near the sub-station. The maximum speeds reached were 63 miles per hour with an eight-car train, and 72 miles per hour with a four-car train. It will be noted that the trains were still accelerating at these speeds, but the length of track so far equipped did not permit of the attainment of higher speeds. These locomotives are not designed for abnormally high speeds at intervals, but rather to obtain a high average rate, due to their ability to accelerate more rapidly than is possible with the present steam locomotives.

In the starting tests, a speed of 30 miles per hour has been reached in 60 seconds with an eight-car train, weighing, including the locomotive, 431 tons, corresponding to an acceleration of one-half mile per hour per second. During certain periods of the acceleration the increase in speed amounted to ·6 miles per hour per second, equivalent to a tractive effort of, approximately, 27,000 lb. developed at the rim of the locomotive drivers. This value was somewhat exceeded with the four-car train, where a momentary input of 4200 ampères developed a tractive effort of 31,000 lb. at the drivers with a coefficient of traction of 22·5 per cent. of weight on drivers. The average rate of acceleration with the four-car train, weighing, including the locomotive, 265 tons, was 30 miles in 37½ seconds, or ·8 miles per hour per second, equivalent to an average tractive effort of 22,000 lb.

The maximum input recorded, 4200 ampères at 460 volts, or 1935 kilowatts, gives an output of the motors of 2200 horse-power available at the wheel. With 4200 ampères and a maintained potential of 600 volts there would have been an input to the locomotive of 2520 kilowatts, corresponding to 2870 horse-power output of the motors. This output is secured without in any way exceeding the safe commutation limit of the motors and with a coefficient of traction of only 22·5 per cent. of the weight upon the drivers. No service capacity temperature runs have been made as yet, and the preliminary tests have not shown any appreciable

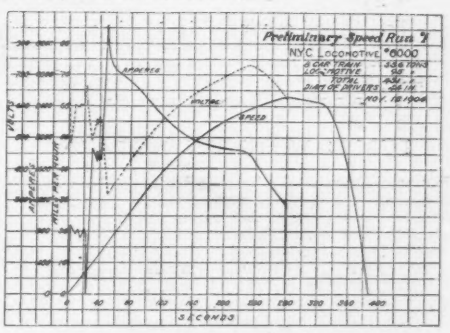


Fig. 10—ACCELERATION CURVE

warming up of the motors sufficiently to take thermometer readings.

The elimination of gear and bearing losses permits of a very high efficiency of the locomotive. Reference to the motor characterics shows a maximum efficiency of approximately 93 per cent., this value being, it is claimed, fully 4 per cent. better than possible with motors of the geared type. This gain is especially noticeable at the high speeds, the efficiency curve remaining above 90 per cent. even at the

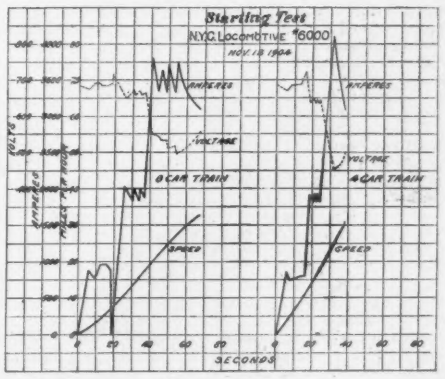


Fig. 11—STARTING TESTS

free running speed of the locomotive alone, in contrast to the 85 per cent. or less, which would be good for a locomotive provided with geared motors.

For these figures we are indebted to the builders of the engine; they are not based on our own observations, but at an exhibition and short trial trip of the engine made on November 12th we were able to observe that the engine got away readily with a 250-ton train, exclusive of the engine,

and attained a speed of a trifle over 60 miles per hour in about three minutes. It also showed no difficulty in handling a heavier train. The cab is commodious, and the engine runs very smoothly, whilst the driving, which was done by a steam locomotive driver, appeared to give no trouble whatever. The official results expressed in the diagrams were taken on autographic instruments, and there can be no doubt of their correctness.

As some discussion as to the protection of third rails has taken place, we may mention that the rail on this experimental line is protected by an inclined board carried on a curved arm springing from the base of the insulator. The distance between the board and the rail is such that one could easily put his foot on it if he so desired, and as it stands at a height that is inconvenient to step over there is some temptation to do so. The Americans would doubtless say that if a trespasser on their property gets killed they cannot be held responsible. At level crossings—Fig. 14—the protection is all that can be desired, since the conductors are taken overhead and the collectors on top of the cab are used in place of the shoes.

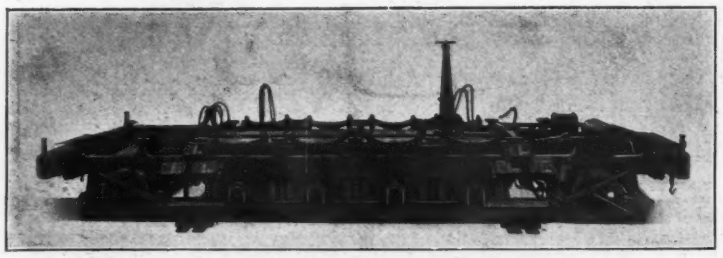


Fig. 12—LOCOMOTIVE PARTLY ASSEMBLED

Fig 13—LOCOMOTIVE AND SEVEN-CAR TRAIN

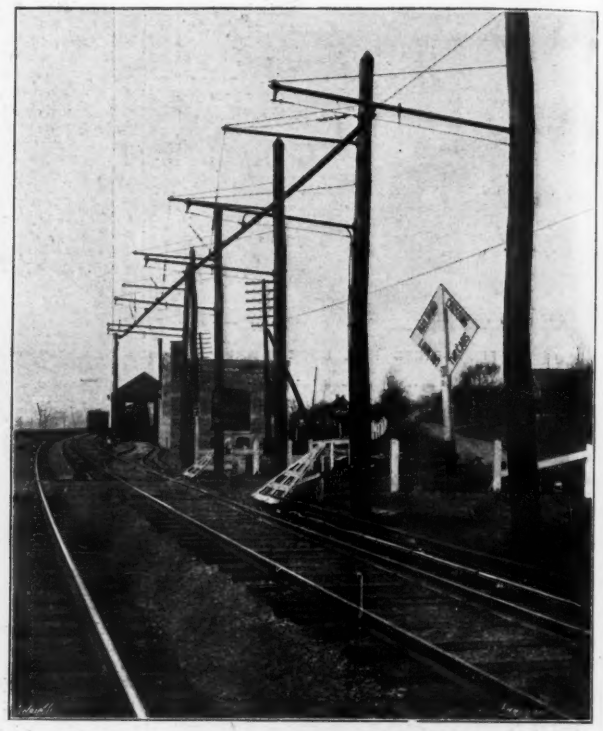


Fig. 14—OVERHEAD CONDUCTOR AT CROSSING

PUBLIC WORKS IN IRELAND.

THE provision made by Parliament, in the form of votes and grants, for the year ending 31st March, 1904, for Public Works and Buildings in Ireland, including National and Ancient Monuments, amounted to £408,000. In the long list of details in the seventy-second Report of the Commissioners, the majority relate to the maintenance of existing works which, in point of magnitude, importance, and expenditure, call for no particular attention. A few, however, deserve mention, especially some of a new description relating to harbours, fisheries, inland navigation, and river and sea projects, all intimately connected with the progress and prosperity of the sister island. Class I., which we are now briefly considering, includes The Phœnix, St. Stephen's Green, and the Curragh of Kildare, honoured with the title of Royal Parks. Their annual upkeep was £12,000, of which total the Phœnix absorbed £10,000. This disproportionate share requires a little explanation. A great storm in the month of February last year destroyed three thousand trees, large and small, and effected such extensive damage that measures were at once adopted for the replanting of the Park.

An undertaking of some consequence has been fairly started, under the provisions of the Public Offices Site (Dublin) Act of 1903. The overcrowded condition of some of the public offices in Dublin, and the need for a new College of Science, have necessitated the acquisition of additional premises for the former, and for the site of the latter. The Commissioners have appointed Sir Ashton Webb, R.A., President of the Royal Institute of British Architects, and Mr. T. Manly Deane, B.H.A., Dublin, Joint Architects for designing and erecting the new Royal College of Science.

In addition to the large number of civil and military establishments and buildings, for which provision is made by vote of Parliament, the report deals with certain new undertakings already alluded to. The cost of these is met out of moneys accruing from the Irish Church Fund, under the Sea Fisheries (Ireland) Act, 1883, and also under the Marine Works Act, 1902. By the first of these Acts, a sum amounting to a quarter of a million was available for the building, improvement, and extension of fishery piers, harbours, jetties, and landing places. During the past year a new pier and viaduct, together with some submarine rock excavation, have been completed at Portagovie, co. Down, at a total cost of £8,300, and the whole transferred to the County Council of Down, upon which authority devolves the onus of maintenance. The funds at present in hand for expenditure upon works in progress, and upon others that may be subsequently undertaken, amount to £10,000. There are in course of construction at Ardmore, co. Waterford, a new breakwater and slips, estimated at £2700; and it will require another year before Newcastle Harbour, co. Down, will be out of the contractor's hands. The procedure under the Marine Works Act, 1902, includes rather an extensive list of proposed harbour improvements. One of the most important comprises the construction of a new pier head and a wharf on opposite sides of the entrance of the harbour at Cape Clear, co. Cork. They are designed to facilitate the ingress and egress of vessels, and will also serve to reduce the swell in both the outer and the inner harbours. Protecting booms, with mechanical appliances to work them, will be placed at the mouth of the inner harbour, and thus render it suitable for the accommodation of the largest class of fishing craft during the winter months. A new slip, and numerous repairs, filling in breaches in walls and dams, and the removal of rocks and shoals, are included in the scheduled list.

At Liscannon, in co. Clare, the harbour area and channel are to be deepened, special berths provided for steamers to lie at, an additional service reach formed for traffic, and groynes erected at the entrance to mitigate the wave action. Contracts have been let for the two works just quoted, and tenders invited in four other cases.

Working plans and specifications have been completed for proposed works at Innishlyre and Touragee in Mayo, and at three points along the coast line of Donegal. In the case of the Innishlyre scheme, negotiations are pending between the Irish Government, the Midland Great Western Railway Company, the Westport Harbour Commissioners, and the Mayo County Council, regarding the proposed works.

The Royal Harbours, Kingstown, Howth, Donaghadee, Dunmore, and Ardglass, were maintained in good and efficient order, at a cost of £12,600, of which total the first-named is debited with the enormously disproportionate share of £9500.

A word or two should be said respecting the fishing industry and trade of these harbours—or, rather, of two of them—as the take of the other three put together did not exceed in value £8000. Howth sold her hook-fish and herrings for £13,230, and Ardglass her's for £10,600. Taken as a whole, the fishing season at the last-mentioned port has been satisfactory. The slight decline in the herring catches was compensated by the great improvement which has taken place in trawling, and, consequently, in the increased quantity of mixed fish landed. It should be noticed that only a few of the boats are owned by local fishermen, and that the Scotch boats had the best takes, owing to superior gear and general equipment.

The arterial drainage of the country and its maintenance are included in the "Details of Non-voted Services." This class comprises the issue of numerous loans, all having for their object the improvement of the different districts to which they are respectively assigned. From 1842 to 1863 sums were advanced for this purpose, under statute, to the amount of over two millions. After the passing of the Drainage and Improvement of Lands Acts (Ireland), 1863, and Amending Acts, £846,000 were disbursed up to the end of the financial year of 1904.

Dredging operations were carried on in connection with the Shannon navigation, at intervals, over some eighty miles of the river's course, from Lanesborough to Limerick. New works, of a minor character, were commenced at Limerick, Killaloe, and upon the upper part of the stream. If to the cost of these be added that of the maintenance of locks, embankments, bridges, buildings, machinery, and all standing and floating plant, an outlay of £6000 cannot be regarded as unreasonable.

Those who are interested in the preservation of ancient and national monuments will find in the report a very full description of the present condition of the Cistercian Abbey of Boyle, founded in the year 1161. Plans and elevations accompany the context, which explains the works of preservation and repair accomplished and contemplated.

THE Mersey Docks and Harbour Board have decided to spend £2500 in dock improvements at Birkenhead. It is proposed to spend £57,700 in the erection of a double-storey shed on the west side of Sandon Dock, and the repavement of the road on the south side of that dock; and also to provide for the better lighting by electricity of the Sandon half-tide and Huskisson docks and branches at a cost of £1440.

TWIN-SCREW CENTRE-LADDER DREDGER.

THERE was launched on the 8th ult. from the works of Messrs. Lobnitz and Co., Limited, Renfrew, a twin-screw, self-propelling, centre ladder, combined hopper and barge-loading dredger, built of steel, to the order of Messrs. the North-Eastern Railway Company. The dimensions of the vessel are as follows:—Length between perpendiculars, 259ft.; breadth, moulded, 45ft.; depth, moulded, 19ft. 5in. The dredger is designed to cut her own flotation, and is constructed to dredge to a depth of 45ft. below the light water line, when the ladder is at an angle of 45 deg. to the vertical, and the capacity of the hopper is 28,800 cubic feet.

The engines are twin-screw triple-expansion, the diameter of cylinders being 17in., 27in., and 43in. by 27in. stroke. Separate condensing and circulating plant have been provided, all the exhaust and waste steam both from main and auxiliary engines being led to the condensers, either condenser being fitted so as to be available for either engine. The gearing in the engine-room has been designed for three speeds of buckets, viz., eighteen, fourteen, and twelve buckets per minute; and a special feature of the gearing is that either engine can drive the buckets at any of the three speeds. This has entailed a considerable amount of trouble and labour in devising a suitable arrangement, but the difficulties encountered have, so we understand, been successfully overcome. Two sets of buckets are provided, the larger buckets measuring 54 cubic feet capacity, for dredging in mud, and the smaller buckets measuring 35 cubic feet capacity, for dredging in clay and other hard material. The backs of the buckets are made of cast steel, with mild steel bodies, and lips of high carbon steel, the material for the lips having a resistance to tensile stress of 40 to 45 tons per square inch, with an elongation of 15 per cent. in a length of 5in. The pins and bushes in the buckets are of Hadfield's forged manganese steel.

There will be two steel cylindrical boilers, each 15ft. diameter, working at a pressure of 180 lb. per square inch. Morison corrugated furnaces being fitted throughout. The whole of the wheels and gearing on the dredger are of cast steel, having double helical teeth. Winches have been fitted at the bow and stern for manœuvring the dredger, the bow winches being provided for working two head chains, $1\frac{1}{16}$in. diameter, and two side chains, in addition to the warping drums for ropes.

The hopper doors are constructed to a new design, so as to hold the very fine mud to be dredged, and are operated by Messrs. Lobnitz' patented hopper door gear. The circulating pumps are of the centrifugal type, and were made by Messrs. Gwynnes, Limited; and the air and feed pumps have been made by Messrs. Lamont and Co., of Paisley. The tumblers are of high carbon cast steel, the bottom tumbler being fitted with a hard liner, and revolving upon a high carbon steel shaft. Messrs. Lobnitz and Co.'s patented device for excluding sand and grit, which this firm has successfully employed in connection with sandpump dredgers, is being fitted for the purpose of excluding sand and mud, and thusl engthening the life of the shaft.

The ladder is a girder 100ft. long, by 7ft. deep in the centre. The combined weight of ladder, bottom tumbler, buckets and links, when finished, will amount to over 200 tons, one bucket, with the corresponding two links and pins, weighing 3 tons 15 cwt. Steam steering gear has been provided, as also has electric light, which is installed throughout the vessel, both above and below deck, both for working and navigating purposes. Repeating telegraphs are being fitted from bridge to bow and stern winches, the engine-room and the ladder-hoisting winch, and also from the ladder-hoisting winch platform to the engine-room.

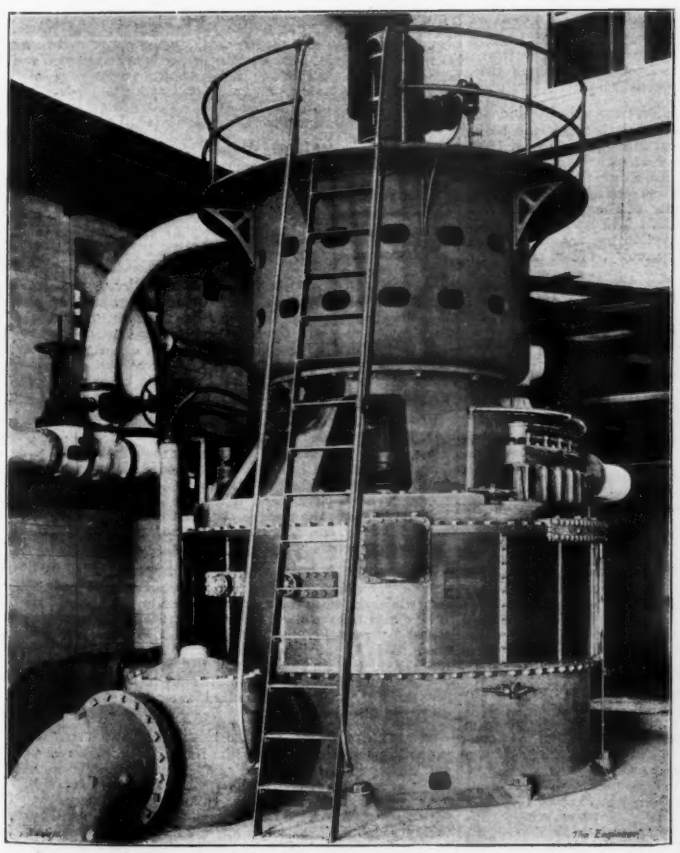
The vessel has been named the David Dale, in compliment to Sir David Dale, Chairman of the Way and Works Committee of the North-Eastern Railway Company. The launch was witnessed by Sir George Gibb, general manager, and the engineers of the North-Eastern Railway Company. The dredger, on completion, is intended to be put to work on the railway company's new Tidal Harbour and Dock Extension Works at the Hartlepools.

ELECTRIFICATION OF THE NEW YORK CENTRAL AND HUDSON RIVER RAILROAD

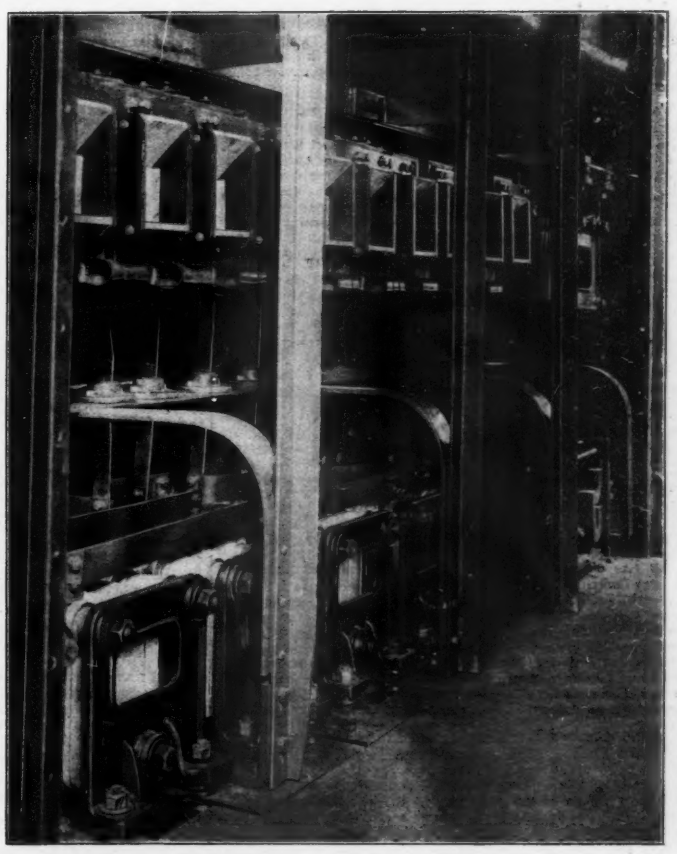
THE GENERAL ELECTRIC COMPANY, AND THE AMERICAN LOCOMOTIVE WORKS SCHENECTADY, ENGINEERS

(*For description see page 542*)

95-TON ELECTRIC LOCOMOTIVE



2000-K.W. FOUR-STAGE CURTIS TURBINE



CONTACTORS AND RHEOSTATS ON LOCOMOTIVES

RAILWAY MATTERS.

AT Barrow, Sunderland, and Darlington the promoters of the new railway from Sunderland to Barrow by way of Darlington and Swaledale are actively seeking support. Mr. F. Stileman is the engineer.

ALONG the line of the Pennsylvania Railroad west of Harrisburg there is a drought so severe that at twenty or more places temporary engines have had to be put in to pump water from streams to supply the locomotives.

IT is stated that the London United Tramways Company will shortly commence the construction of the whole of the authorised lines, fifteen miles in extent, in Kingston, Surbiton, the Dittons, Molesey, New Malden, and Wimbledon. Irrespective of street widenings, the cost will be about half a million sterling.

THE South-Eastern and Chatham Railway announces that a special train will leave Boulogne for Marseilles, Cannes, Nice, Mentone, and Monte Carlo on Friday, December 23rd, in connection with a special express train from Charing Cross Station at 2.15 p.m. by the short sea route, *vid* Folkestone and Boulogne.

IN spite of the now almost general adoption of automatic couplers and brakes in the United States, the record of coupling accidents continues to increase, says the *Railway Age*, this class of casualties showing last year 278 killed and 3441 injured, compared with 143 killed and 2113 injured two years before, in 1902.

AN attempt is to be made to secure the passage of an Act by the New York Legislature at the next session prohibiting the transportation of goods through the city streets in that State by means of electric railways. It is difficult, says the *Street Railway Review*, to imagine a movement which has behind it so little reason.

IT is reported that the Pennsylvania Railroad Company has placed an order for 6200 freight cars, 6000 of which are to replace damaged and worn out cars on the lines east and west of Pittsburg. The orders for the cars have been about equally distributed among the American Car and Foundry Company, the Pressed Steel Car Company, the Standard Steel Car Company, and the Cambria Steel Company.

MR. J. A. F. ASPINALL, general manager of the Lancashire and Yorkshire Railway Company; Mr. C. W. Bailey, chief traffic manager; and Mr. J. Wharton, goods manager, are making a tour of the principal continental ports in connection with their company's scheme, authorised by Parliament last session, for running steamships between Goole and Hull and Antwerp, Hamburg, Ghent, Heyst, and other parts of the Continent.

THE contract has been let for making five lots of the Paris Metropolitan Line No. 4—north and south—and, thanks to the Government Commission presided over by M. Henry Marcel, the project for the terminus of Line No. 7 under the Place du Carrousel is now well under weigh. The Municipal Commission has, on the report of M. Félix Roussel, approved of the Prefectoral requirements for additional access to the Nation, Belleville, Clichy, and Dauphine stations.

THE coal and coke carried by the English and Scotch railways last year, 1903, amounted to 161,499,851 tons. The largest quantity was carried by the North-Eastern, viz., 33,863,540 tons; the Midland stands second with 21,209,583 tons; the London and North-Western third with 19,152,000 tons; the Great Western fourth with 17,167,000 tons; and the North British fifth with 14,883,000 tons. The Caledonian carried 12,090,000 tons and the Great Central 9,411,000 tons.

THE consensus of opinion in America is apparently strongly in favour of single-phase motors for railway work, and although polyphase motors have made substantial progress on a number of continental railways, they are not looked upon favourably by American engineers, says the *Street Railway Review*. The polyphase induction motor is practically a constant speed machine, and for this reason is not so suitable for electric traction as a motor capable of variable speed, whose torque decreases as the speed increases.

A SCHEME for an overhead electric railway from east to west above the Regent's Canal has been mooted. The canal runs for $10\frac{3}{4}$ miles through a populous commercial district from the East of London to Paddington. One of the leading officials of the Regent's Canal and Dock Company has stated that, although the canal company is not a promoter of it, it is aware of the details, and not averse to such a development of its property. As the route of the proposed line is open, it is pointed out that the cost of construction will be light.

FOR the first time in fifteen years the railways of Victoria show this year a surplus of gross income over working expenses and interest on State loans. The report for the year ending June 30th, 1904, shows a surplus of £500 over and above all charges, and in many other details indicates a strong and successful effort on the part of the Railway Commissioners to operate the lines on a paying basis. Early in 1903 Mr. Thomas Tait, then manager of transportation on the Canadian Pacific, was appointed chairman of the Victorian Railway Commissioners.

THE Côte d'Azur Rapide, put on during the past month by the Paris-Lyons-Méditerranée Company, runs over the 1000 kiloms. (= 621 miles) that separate Paris and Mentone in less than fourteen hours, giving a mean of 84 kiloms. (= 52 miles) an hour. The noteworthy point about the new train, weighing about 180 tons, and made up of two first-class carriages, with sleeping compartments, a saloon car, a restaurant car, and a brake van, is not so much the high speed as the sustained effort over so long a distance, notwithstanding great variations of level.

AT last week's meeting of the London County Council the Highways Committee recommended that parliamentary powers be sought in the session of 1905 to enable the Council to construct tramways from the present terminus in Blackfriars-road across Blackfriars Bridge and along the Victoria Embankment as far as Waterloo Bridge, and to effect the necessary junctions between this and other lines. The report was adopted. The total length of the whole of the proposed line is $1\frac{3}{8}$ miles; the estimated cost of construction on the underground conduit system is £103,000.

AT the ordinary general meeting of the Kal Ka Simla Railway Company, held in London this week, Colonel A. J. Filgate, R.E., who presided, said that additional works which they had forced to undertake had again added considerably to the cost of the line, and the magnitude of the works, and the difficulties encountered in construction, had far exceeded the forecast of the Government and the company's officers, who investigated the profits. In order to secure the Secretary of State for the advances he was making to the company, it was necessary to increase the borrowing powers from £650,000 to £800,000.

ACCORDING to a Reuter telegram from the Hague, Baron Melvil van Lynden, Minister for Foreign Affairs, has published a written reply to the report of the committee of the Second Chamber on the estimates for his department, in the course of which, dealing with the question of the Netherlands Railway, he says that the Government, which regards the railway as still in existence, as long as the liquidation has not been completed, and as being always able to make good its legitimate claims as against Great Britain, has proposed to that Power to terminate the affair by submitting the questions of international law, the solution of which is imperative, to The Hague Court of Arbitration.

NOTES AND MEMORANDA.

THE man who has the highest situation in the world is the station master of the Gornergratt terminus, near Zermatt, at an altitude of 3246 metres—10,650ft. above sea level.

A TURNER'S workshop, with large motive wheel and dog trained to turn it, is advertised to be let in the city of Liège, where one-dog and two-dog tilted carts and wagons are common.

THE second French wireless telegraph station, that of Porquerolles, has been opened for affording communication between vessels at sea and France, Corsica, Algeria, Tunis, Monaco, and Andorra.

AN Austrian inventor has constructed a yacht—hull, sails, masts, and rudder—from 300,000 numbers of a daily Vienna journal, the issue of two days. The pulped paper was compressed in moulds made for the purpose; and the yacht takes the water perfectly.

THE importation of raw cotton direct to Manchester is much brisker this season than it was last. Already 116,626 bales have been received at the port, an increase of 34,000 bales, compared with the corresponding period of last year. The figures of this season are approaching those of two years ago, when the record importation direct to Manchester was reached.

THE last of a series of patents has been granted to a German company for a new dry process for degreasing wool. Infusioral earth, as an absorbent, is the kernel of the scheme. The earth is applied in the wool with great force by a current of air generated by specially constructed but inexpensive machinery. The wool is cleaned and degreased evenly throughout.

IN 1850 the average consumption of cement per head in the United States was 6 lb. For many years it increased very slowly, being 10 lb. in 1860, 12 lb. in 1870, and only 13 lb. in 1880. In 1890 the consumption per head had grown to 34 lb., while in 1900 it had reached 91 lb., and in 1902 it was 119 lb. per head. These figures illustrate the rapid gain of the industry in recent years.

THE Mexican Chambers have passed a Bill for the reform of the currency laws. The dollar will in future contain 25·4388 grammes of fine silver and 2·6342 grammes of copper, equivalent to 75 centigrames of fine gold. The coinage and issue of money are reserved to the Government. The new law authorises the Government to prevent or impose a tax on the importation of Mexican dollars.

A PAPER describing researches on dielectric solids was contributed recently to the Paris Academy of Sciences by V. Crémieu and L. Malcles. In the course of his researches on electric convection Crémieu observed some anomalies of electrical influence through solid dielectrics. The authors have commenced a systematic study of these phenomena, and give an account in the present paper of the apparatus used, reserving the results for a future communication.

THE Berlin correspondent of the *Standard* reports an interesting legal tangle for owners of motor cars in Germany. According to a law passed in 1901, a motorist can be punished for allowing his car to give off too great a smell of benzine. A German automobilist was fined for this offence recently and appealed to a higher Court. It has now been decided that punishment for such an offence can only be meted out "when the smell of the benzine is so great as to force passers-by to take another road to that used by the automobilist in question."

ACCORDING to a return just issued, there was expended on technical education in England and Wales during the year 1902-3 the sum of £1,191,998 3s. This amount is exclusive of the sums allocated to intermediate and technical education under the Welsh Intermediate Education Act, 1889. The amount raised by loan on the security of the local rate under the Technical Instruction Acts was £149,685 1s. 6d. The amount of loans—so raised—outstanding was £1,159,941 11s. 7d., and the balance in hand of moneys received and allocated to technical instruction was £598,989 7s. 3d.

WEDNESDAY was the last day for depositing plans in connection with Private Bills to be promoted in the ensuing session of Parliament. At eight o'clock, at which hour the Private Bill-office closed, 224 such deposits had been made, of which 27 related to railways, 9 to tramways, 128 to Provisional Orders, and 60 to miscellaneous measures. Last year the deposits totalled 272, subdivided as follows:—Railways, 27; tramways, 26; miscellaneous, 61, and Provisional Orders, 158. It is noteworthy that the figures of last year showed a decrease upon those of the preceding year, and that a still further decrease is apparent this year.

THE Greek troops are to receive a new rifle in place of the 11 mm. Gras rifle. The competition is between the Krag-Jörgensen, Mauser, and the 6·5 mm. Mannlicher, model 1903, according to the *Berliner Militar Wochenblatt*. It has also been decided to change the 2·95in. and 3·42in. Krupp field guns for new quick-firers of the latest models. The competing firms are Krupp, Ehrhardt, Skoda, Schneider, and others. The cost of supplying from 120,000 to 150,000 new rifles and 24 field and six mountain batteries of six guns each is expected to amount to between £1,200,000 and £1,600,000, which, if necessary, will be raised by a loan.

THE launch of the French submarine X took place recently at Cherbourg. She is one of three experimental vessels in which an attempt is made to combine the advantages and to avoid the disadvantages of submarine and submersible. The three boats are not of the same displacement, X being 168 tons, Z 202 tons, and Y 213 tons. X has length 122·7ft., beam 10·23ft., draught aft 7·54ft. She is to have accumulators for electric motive power when submerged, and gas or vapour engines when on the surface. The exact type of the latter has not yet been decided, says *Le Yacht*, but it is to be of about 220 horse-power and to give a speed of 10·5 knots.

THE 15,000-ton United States battleship New Jersey was launched at Quincy, Mass., on November 10th. The vessel is 435ft. long and 76ft. $2\frac{1}{2}$in. broad on load water-line, and draws about 24ft. The trial displacement will be close to 15,000 tons. It is intended to make a speed of 19 knots. The propelling power is furnished by two four-cylinder triple-expansion engines of 19,000 indicated horse-power, driving twin screws. The main armament of the New Jersey comprises four 12in. rifles and a gun-deck broadside battery of twelve 6in. rifles, six on each side. Torpedo tubes are also provided. The vessel is armoured with an 8ft water-line belt, full length, 11in. to 4in. thick, and a 6in. case-mate belt 245ft. long.

THE use of helium as a thermometric substance and its diffusion through silica formed the subject of a paper read before the Paris Academy of Sciences lately by MM Adrien Jaquerod and F. L. Perrot. It described an attempt to determine the melting point of gold with a thermometer of fused silica, and containing helium, which failed owing to the rapid diffusion of the gas through the silica at the high temperature. The velocity of diffusion appears to be proportional to the pressure of the gas, and is very considerable, since after six hours' heating at 1100 deg. Cent. the pressure of the helium had fallen to about one-seventh of the initial pressure. Below a red heat, at about 510 deg. Cent., the diffusion is still fairly rapid, and a very slow effect could even be traced at 220 deg. Cent. For practical purposes, therefore, the nitrogen thermometer remains the best instrument for high temperatures.

MISCELLANEA.

FIFTEEN new steamers, of a total tonnage of 117,800, have been ordered by the Hamburg-America to replace the vessels sold to the Russian Government.

AN inquiry has been held into the application of the Scarborough Town Council to borrow £65,000 for works of sewage disposal on the bacteriological system.

THE Southport borough surveyor is preparing a modified scheme for the purification of the effluent at Crossens sewage works, which will cost from £15,000 to £20,000.

AN inquiry was held yesterday into the application of the Devonport Borough Council to borrow £7958 for the extension of the generating plant at the Corporation electricity works.

THE Monmouthshire County Council have decided to replace the old Kemeys chain bridge on the road from Abergavenny to Usk, by a steel suspension bridge, designed by Mr. J. J. Webster, with one span of 150ft. It is hoped that the new bridge will be completed in twelve months.

THE construction of the new lock at Molesey will, we understand, be commenced next October by the Thames Conservancy. The cost will be £10,750, and the work will be undertaken by the Works Department. A temporary lock will previously be built at an estimated cost of £2210.

NEGOTIATIONS by Messrs. Cammell, Laird and Co., for the purchase of Lord Lonsdale's dock and harbour at Workington, have proved successful, and agreements have been signed. Parliamentary powers are necessary for the dock and harbour extensions, and this step is being taken.

EIGHT petrol motor omnibuses, forming the greater portion of the service which has been plying for some time between the Marble Arch and Kilburn, were destroyed by fire on Saturday night. The conflagration is supposed to have been caused by an attendant using an oil lamp while engaged in cleaning operations.

THE Council of the Edinburgh Royal Society have decided to award Professor Sir James Dewar the Gunning Victoria Jubilee Prize for 1900-1904 for his researches on the liquefaction of gases, extending over the last quarter of a century, and on the chemical and physical properties of substances at low temperatures.

THE Council of the Royal Society of Edinburgh, at its recent meeting, decided to award Professor Sir James Dewar, F.R.S., the Gunning Victoria Jubilee Prize for 1900-1904, for his researches on the liquefaction of gases extending over the last quarter of a century, and on the chemical and physical properties of substances at low temperatures.

A COMMENCEMENT has been made with the new water supply scheme for Skipton. The scheme, which is estimated to cost about £70,000, contemplates a reservoir at the foot of Embsay Moor, just over two miles from Skipton, with the necessary line of pipes to the town. The parliamentary powers permit of the laying of a new permanent main from the source of supply to Skipton.

INDEPENDENTLY of the general survey of Greece, which is being carried out by the Ministry of War, a survey of Thessaly having in view important hydraulic works, has been entrusted to a foreign engineer. The matter is in charge of a Thessalian Commission. It is hoped that it may be possible to drain extensive areas of marshy land and to increase the fertility of others by irrigation.

AFTER an exceedingly rough voyage from Holland, the dredger Thames, built on the Frühling system, and owned by the British Dredging Company, Limited, arrived safely at her destination—the Manchester Ship Canal. The vessel encountered very heavy seas in the Irish Channel, but came through without damage. The Thames has now commenced operations in the Manchester Ship Canal.

A SYSTEM of electric heaters of novel form is being installed on the new steamship Minnesota. There are 150 heaters, each measuring 15in. by 7in., $2\frac{1}{2}$in. deep. Eight heat units, with a capacity of 100 watts each, can be operated by means of proper switches, so that three, five, or eight are in action at the will of the occupant of the state room. The heaters are supplied with current at 230 volts.

THE Admiralty yacht Enchantress has been placed in No. 2 basin in Portsmouth Dockyard, in order that certain alterations may be made at once. The bridge is to be removed and the chart-house shifted further aft, so as to leave a gangway before it. The funnel is to be shortened and fitted with a bell mouth, and the vessel is to be painted black. Various alterations are also to be undertaken with regard to the present internal arrangements.

AT the recent annual meeting of the River Weaver Trust, it was stated that expert advice had been obtained regarding the state of repair of the Anderton lift. As the estimated expenditure involved was considerably greater than the estimated margin of revenue over expenditure during the next two or three years, it had been found necessary to give notice of a Bill in Parliament to obtain further borrowing powers to the extent of £30,000.

A CONSULAR report from Callao, Peru, reports that there is a very large coal area in the Department of Ancachs. It is found about sixty-six miles from the port of Chimbote. In the Santa Valley coal exists in immense quantities; in fact, it is said that it can be traced for twenty miles. Although experiments made last year with Ancachs coal for steam purposes did not give satisfactory results, it might be used for domestic purposes.

AN automobile vedette, with explosion motor, has been purchased at Maisons-Laffitte, near Paris, by the Russian Government, for being carried on board a war vessel. The Neva, as the boat is named, is 16 m. (33ft.) long and 2 m. (6½ft.) beam, with 60 cm. (2ft.) draught of water. The total weight is 2·3 tons, the power 40 horse-power, and the speed 14 knots. The cabin will hold twelve men, the deck is convex, the engine is protected by a movable casing, and there are two water-tight compartments for ensuring insubmersibility.

THE great energy displayed in road construction in Greece under M. Tricoupis' influence between 1883 and 1893 was somewhat relaxed in the succeeding decade. Whereas 1346 miles of new road were made in the former period, only 825 miles were added between 1893 and 1903. Although there are now many good roads in the interior of Greece, anyone who realises how much good communications add to the wealth of a country, and how much Greece, especially in the more productive districts, still falls short of a reasonable standard, must hope to see a revival of energy in this direction.

NEGOTIATIONS for the settlement of the wages dispute in the shipbuilding trades on the North-East Coast were resumed on Tuesday in Newcastle-on-Tyne. The shipyard labourers separately accepted a compromise, agreeing that there should be 5 per cent. reduction of piece rates, 1s. a week from the wages of men earning 25s. and over, 6d. from the wages under 25s. and over 22s., and no reduction from wages under 22s. The boilermakers agreed to accept the employers' terms, subject to the reductions not taking place until the first full pay in January. The shipwrights had the same offer made to them, and they have asked for a day's grace to consider the matter.

FOREIGN AGENTS FOR SALE OF THE ENGINEER.

AUSTRIA.—F. A. BROCKHAUS, 7, *Kumpfgasse, Vienna.*
CHINA.—KELLY AND WALSH, LIMITED, *Shanghai and Hong Kong.*
FRANCE.—BOYVEAU AND CHEVILLET, *Rue de la Banque, Paris.*
GERMANY.—ASHER AND CO., 13, *Unter den Linden, Berlin.*
F. A. BROCKHAUS, *Leipzic*; A. TWEITMEYER, *Leipzic.*
INDIA.—A. J. COMBRIDGE AND CO., *Railway Bookstalls, Bombay.*
ITALY.—LOESCHER AND CO., 307, *Corso, Rome*; BOCCA FRERES, *Turin.*
JAPAN.—KELLY AND WALSH, LIMITED, *Yokohama.*
Z. P. MARUYA AND CO., 14, *Nihonbashi Tori Sanchome, Tokyo.*
RUSSIA.—C. RICKER, 14, *Nevsky Prospect, St. Petersburg.*
S. AFRICA.—WM. DAWSON & SONS, LIMITED, 7, *Sea-st.* (*Box* 489), *Capetown.*
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*** *With this week's number is issued as a Supplement, a Two-page Drawing of a Narrow-gauge Locomotive, Mexican Railways. Every copy as issued by the Publisher includes a copy of the Supplement, and subscribers are requested to notify the fact should they not receive it.*

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TWO-PAGE SUPPLEMENT—NARROW-GAUGE CONSOLIDATION LOCOMOTIVE.

TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

J. A. D. (Pure air for the blast furnace).—You have forgotten to send your address.

P. W. (Tower Hill).—The chief mechanical engineer of the Chemin de Fer du Nord is M. G. du Bousquet.

KLON. (Derby).—A cubic yard is usually considered a load. Two pennyweights of gold would be worth about 7s. 6d.

ENGINEER (Ireland).—We think Simms' "Practical Tunnelling" will supply the information which you seek. If not, write again.

J. (Worthing).—Make the area of the jet in your condenser $\frac{1}{15}$ of the area of the piston. If you add about 1 per cent. of tin to the brass of which your tube is made it will not corrode.

SPUR (Nottingham).—Formula given by D. K. Clark for the power which may be transmitted by spur gearing is, for cast iron $H = \frac{P^2 D S}{58 \cdot 3}$.

Here H = horse-power; D, diameter in feet; S, revolutions per minute; and 58·3 a constant.

W. B. A. S. (Dublin).—Aluminium cannot be soldered. Success has been claimed over and over again, but it is now tacitly admitted on all hands that a method of soldering has yet to be discovered. Union might be effected in a deoxidising flame, perhaps, but work of that kind is out of the range of practice.

INQUIRIES.

"SILEX" LINING.

SIR,—Can any of your readers oblige me with the address of the makers of a hard lining for tube mills known as "Silex?" M. C.
November 29th.

MEETINGS NEXT WEEK.

INSTITUTE OF MARINE ENGINEERS.—Monday, December 5th, at 8 p.m., at 58, Romford-road, Stratford, E. "Fuel Testing."

THE JUNIOR INSTITUTION OF ENGINEERS.—Saturday, December 10th, at 3 p.m. Visit the International Gas Exhibition at Earl's Court.

THE INSTITUTE OF SANITARY ENGINEERS, LIMITED.—Wednesday, December 7th, at 4.30 p.m. Half-yearly general meeting. At 6.30 p.m. Annual dinner, at the Holborn Restaurant.

THE UNIVERSITY OF LIVERPOOL ENGINEERING SOCIETY.—Tuesday, December 6th, at 5.30 p.m., in the Engineering Lecture Hall. Paper, "Gold Mining in the Transvaal," by Professor Hele-Shaw, LL.D., F.R.S., President.

CLEVELAND INSTITUTION OF ENGINEERS.—Monday, December 5th, at 7.30 p.m., in the Hall of the Cleveland Literary and Philosophical Society, Corporation-road, Middlesbrough. Paper, "Thermometers and Pyrometers with some of their Industrial Applications," by Mr. Robert S. Whipple, Manager of the Cambridge Scientific Instrument Company.

SOCIETY OF ARTS.—Monday, December 5th, at 8 p.m. Cantor lectures: II. "Musical Wind Instruments," by David James Blaikley. Wednesday, December 7th, at 8 p.m. Ordinary meeting. Paper, "The International Exhibition at St. Louis, U.S.A.," by Walter Francis Reid, F.I.C., F.C.S. Thursday, December 8th, at 4.30 p.m. Indian Section. Paper, "Burma," by Sir Frederic W. R. Fryer, K.C.S.I., late Lieutenant-Governor of Burma.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, December 8th, at 8 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Ordinary general meeting. Discussion, "Hydrodynamical and Electro-magnetic Investigations regarding the Magnetic-flux Distribution in Toothed Core Armatures," by Prof. H. S. Hele-Shaw, F.R.S., A. Hay, D.Sc., Member, and P. H. Powell, M.Sc. Paper, "Studies in Magnetic Testing," by G. F. C. Searle, N.A.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 6th, at 8 p.m. Ordinary meeting. Discussion on "Distribution of Electrical Energy," by John Francis Cleverton Snell, M. Inst. C.E. Paper, "On the Construction of a Concrete Railway Viaduct," by Arthur Wood-Hill, Assoc. M. Inst. C.E., and Edward Davy Pain, B.A., Stud. Inst. C.E. Wednesday, December 7th. Students' Visit to the Motor Car Works of Messrs. D. Napier and Son, Acton Vale, W.

THE ENGINEER.

DECEMBER 2, 1904.

PRIMING AND BAFFLE PLATES.

A PAPER, to be read by Mr. A. Bement at the New York December meeting of the American Institution of Mechanical Engineers, is of very great value, being the record of the first serious attempt, so far as we are aware, that has been made to investigate a cause of priming and the remedy for it. We say "a cause," because no doubt there are many reasons why steam carries water with it into an engine. At the proper time, after the paper has been read, we shall publish it in our columns. Our purpose now is to direct attention to its salient features and the lessons which may be deduced from the investigation carried out by Mr. Bement in, we assume—although so much is not expressly stated—a large power-house in Chicago. The title of the paper runs, "A Bad Case of Discharge of Water with Steam from Water-tube Boilers," and the communication possesses peculiar interest as suggesting an explanation of the great loss of water which has occurred at sea with Belleville boilers in the British Navy.

It will be seen before we have done that Mr. Bement does not beat about the bush. He has not a word to say about the merits or demerits of the boilers; he has taken them as he found them, and set to work to find a remedy for their paramount defect. The investigation was carried out on a very large scale. The engines seriously affected were two out of twelve, and indicated jointly 10,000 horse-power. The total plant is of 19,790 kilowatt capacity. Steam is supplied by twenty-four Heine water-tube boilers, varying in heating surface between 3800 and 4800 square feet. The type is not unlike the Babcock and Wilcox. Each boiler has a chain grate with 72 square feet of surface; the pressure is 175 lb. The tubes deliver at the front end into headers, which discharge into horizontal steam drums, two to each boiler, 42in. in diameter and 18ft. long. Steam is drawn off for the engines from the front or elevated end of the drum, and of necessity just over the delivery from the vertical header into the drum. A baffle plate was fitted in each drum set on an incline, the lowest end being next the front end of the drum. A perforated plate was also fitted under the end of the steam pipe. The steam pipes are of large size and fitted with separators.

Priming always presents anomalies and inconsistencies perplexing in kind and vexatious in fact. We have no exception to the rule here. The first fourteen boilers started, always supplied with ostensibly dry steam ten vertical, triple-expansion, directly connected engines, of which two developed 880 kilowatts each, and eight 440 each. As nearly as could be estimated the percentage of water in the steam did not exceed about 1·5. It was the practice to fill the boilers nearly to the top of the water-gauge glass just before the peak of the load came on, to help the plant over the period of maximum steam consumption. But the boilers carried their water quite well at this high level. An addition was made to the plant of two vertical cross compound Reynolds-Corliss engines, one of about 4500 and the other of 3250 kilowatts. Two of the existing boilers, known as 13 and 14, were taken off the service already described, and coupled up to ten more boilers of the same Heine type. As soon as the new engines were started trouble began. Water was carried over. The result was failure to effect lubrication of the valves, resulting in their not closing and the breaking of valve arms. The joint between the cylinders and covers is a tongue and groove, in which a flexible packing is compressed; this joint failed as often as renewed, and at times water squirted from the joints of the high-pressure cylinders. "Trouble was always greatest with heavy load on the engines, with either high or low water in the boilers. While there was more trouble with high than with low water, these conditions had less effect than did the engine load. The amount of water passing the high-pressure cylinders was so great that the drains from the intermediate receiver were not sufficient to remove it; for this reason they were increased in area. These engines have a manhole through the top head of the low-pressure cylinder, closed by an inner and outer cover; before the receiver drains were enlarged the accumulation of water became great enough, on one occasion, to cause a sufficient quantity to enter the low-pressure cylinder and to break the bolts holding the inner cover. Owing to the failure of the high-pressure steam valves to close, the receiver pressure would rise to at least 40 lb., at which point the relief valve was set; this extreme pressure under the low-pressure piston was sufficient not only to raise the shaft, fly-wheel, generator, &c., but on one occasion caused one of the 4in. bolts which holds down the cap of the main journal to be pulled up a sufficient amount to allow the revolving fields of the generator to strike." It goes without saying that this part of the plant was almost useless, and a remedy had to be sought.

At this point it will scarcely have failed to escape our readers' attention that boilers which were quite satisfactory with one type of engine failed completely with another. The fact is very suggestive, and it will be seen that Mr. Bement did not pass it over in silence. We seem to have here a possible explanation of one curious anomaly in the performance of water-tube boilers. We must not consider the boiler as a distinct unit, but deal with it and the engine which it supplies as a whole. Mr. Bement held that the baffle plate had something to do with the matter, and his paper is an account of the various experiments made with bafflers, which had no success until he had a large model made, with a glass drum. With the aid of this he discovered and put into use an absurdly simple modification of the baffle plates, with the result that the boilers no longer sent water into the engines, supplying instead only dry steam.

An analysis of the facts shows that all the trouble was due to the water flowing up the incline of the baffle plates, turning over the edge, and filling the space between the plate and the top of the receiver. This water was carried at once by the steam draught into the engines. By riveting a couple of cross deflector plates on to the underside of the baffle plate the water was prevented from rising over its edge, and was directed downward and backwards along the steam drum. The reason why the boiler primed when the Reynolds-Corliss engine was put on is explained by Mr. Bement. He shows that

water was projected up the tube header with such violence that it loosened the rivets and broke away steel baffle plates; this result being brought about by the irregular demand for steam due to the sudden opening and closing of the Corliss valves, which set up a true water-hammer action. With an engine cutting off steam at quarter stroke, it will during the admission period, take steam at a rate four times faster than that at which it is being generated. The performance in the boiler is divided into three periods—a very high peak of evaporation, followed by a brief interval of no evaporation at all, and then a longer period of evaporation at the normal rate. It is the peaks of evaporation which cause the water—or most of it—to be lifted over the baffle plates and thence into the engine. Now, the more slowly the engine runs the greater will be the duration of the periods and the more violent the action during the peaks, or time during which the admission valve is open.

Concerning separators and calorimeters Mr. Bement has a good deal to say. The former were practically quite useless, except in that as they augmented steam storage capacity they did good by modifying the peaks referred to above. Calorimeters of the Carpenter type he holds to be quite fallacious, because the steam varies in quality and the amount of water it contains according to its position in the steam pipe. The wet steam is always found along the walls of the steam pipe, the dry steam in the middle of it. This has been said in our columns many times. Altogether, the results of the investigation are satisfactory. They show that the circulation in a water-tube boiler may not only be good but violent, yet that it is possible by using properly constructed baffles to get dry steam into the engine. The very large practical scale on which the investigation was carried out adds much to its value.

THE POSITION OF BELGIAN STEEL WORKS.

WE have dealt very fully at various times with the position of the German steel trade, but competition does not come from Germany alone. Belgium has also to be considered. Now the severity of competition in the markets of the world has been a cause of frequent complaint for many months past on the part of most of the Belgian iron and steel works, which so largely depend for prosperity upon the possibility of maintaining and extending the export trade, and which rival British works in regard to rails, joists, sheets, and other finished products. It has often been stated for months past that many of the Belgian works, with the object of keeping their machinery and plant in operation as far as possible in order to reduce the cost of production, have been compelled to accept contracts at unremunerative prices; and this assertion is to some extent borne out by the trading results of a number of the works during the past financial year. This is particularly the case with the mere rolling mills, which have to purchase semi-finished steel largely from Germany and France, and which are therefore less favourably situated than those which produce and work up their own output of raw materials. The Belgians, in common with the Germans, have lost the United States market for the time being, if not that in Canada; but, notwithstanding this, the total exports of iron and steel from Belgium this year only show a moderate decline as compared with the heavy reduction in the exports from Germany, and the less considerable diminution in the total quantity sent out of the United Kingdom in the same period. The moderate falling off of the Belgian export department is remarkable when it is remembered that it is contrasted with a period forming the greater portion of the record year 1903. When the international position is taken into consideration it is found that the only two principal countries which have increased their exports of iron and steel during the present year are the United States and France, the latter of which is gradually becoming of more importance from an export point of view.

The results of competition and depression in prices, notwithstanding the increased turnover which has taken place in various cases, are naturally reflected in the balance-sheets of a number of the Belgian works for the financial year 1903-04. Of course, all the works have not suffered from the situation of affairs. A great deal depends upon the business management both in the past and the present, the technical equipment of the works, and other matters, although extensions of works have possibly not always been dictated by sound commercial policy. However that may be, a brief reference to the financial returns which are now available may be of interest at the moment. In the first place, the John Cockerill Company of Seraing which has a share capital of £400,000, has declared a dividend at the rate of 12 per cent. for 1903-04, this being the same rate as in the preceding year. The Athus Blast Furnace and Steelworks Company comes second with a distribution of 6 per cent. on a capital of £160,000; the Alliance Ironworks and Rolling Mills Company is third with 6 per cent. on £40,000; the Charleroi Steelworks Company is fourth with 5 per cent. on £40,000; the Delloye-Matthieu Sheet Mills Company occupies the fifth place with 5 per cent. on £70,000; and the Mining and Metallurgical Company of Monceau-sur-Sambre is sixth with 3 per cent. on a capital of £200,000; while the Marais Ironworks and Rolling Mills Company ranks last with a dividend at the rate of 2½ per cent. on a share capital of £40,000. As compared with these moderate returns on the invested capital—of course excepting the Cockerill Company—a disastrous record is shown by many other works for the past financial year in the sense that they are unable to pay any dividends for this period. These are the Sambre and Moselle Company, on a capital of £640,000; the Marcinelle and Couillet Company, on £520,480; the Angleur Steel Works Company, £400,000; the Thy-le-Château Company, £120,000; the Bonehill Company, £120,000; and the Charleroi Iron Manufacturing Company, on £88,000. Among the other works which have a less share capital than the last mentioned, and which have also proved to be unremunerative in the past year, may be cited the Baume Ironworks and Rolling Mills, the Aiseau Ironworks, the Louvière Sheet Mills, the Phœnix Works of Châtelineau and the Ruau Rolling Mills of Monceau-sur-Sambre. In some cases the companies which have been unable to pay a dividend have earned net profits; but it has been found advisable to devote them mainly to the purpose of depreciation of plant and machinery.

The preceding statement of the position of the majority of the Belgian iron and steel companies confirms the opinion that many of them have either been working at a small profit or at a loss in order to provide orders for the works. It is possible that if the foreign trade in the year under consideration had not been cultivated so largely as it was, the profits, where earned, would have been less, and the losses, where made, would have been greater. Hence it is that the production and exports have been promoted with the object of reducing the standing charges per ton of output. But the future is not free from anxiety. The international rail convention, composed of British, German, Belgian, and French works, has not yet been finally settled, although there is little doubt on the question. The joist syndicate, which is to include the German, Belgian, and French works, has also not been definitely concluded, while the projected semi-finished steel combination of the same works has not made any progress, and is not likely to do so until the rail and joist organisations have been brought into existence. The delay in the ratification of the international rail convention, although attributed to one group of works, may perhaps be due to the proposed negotiations for the inclusion of the American works; but this would necessitate a re-arrangement of the allotments made to the four countries which are provisionally in agreement, and would probably cause friction to arise. The only possible advantages to British works from the three conventions relate to the removal of competition in regard to rails; but in the case of joists the former will continue to be subject to Belgian and German rivalry, with the competition of Germany and the United States thrown into the bargain in the matter of semi-finished steel. It seems a question whether the possible gain to British works from the rail convention will not be more than counterbalanced by the more severe foreign competition which must necessarily arise in this country from a combination of producers of joists and semi-finished steel in Germany, Belgium, and France.

NOZZLES AND FANS.

CERTAIN instruments and forms of mechanism are not infrequently designed by the mathematician, treated as though they were real, and made the subject of careful analytic and synthetic investigation. In this way more or less excellent algebraic exercises are framed for the student, and serve to enhance the reputation of those with whom they originate. The mechanical world at large takes little heed, however, until some day it is discovered that the imaginary has become real. The precise thing, or something like it, about which the mathematician has been writing turns out to be essential to the practical engineer. He seeks for guidance in what has been written about this, and finds to his dismay or annoyance that no useful information is available. Then he denounces the theorist, and falls foul of mathematics. This is, however, quite unjustifiable. The only excuse for it is to be found in the attitude of the mathematician who claims infallibility.

Many examples might be adduced of the lack of useful information hid under the cloud of an elaborate paper investigation. Two suggest themselves. The first is the diverging nozzle, and the second is the ventilating fan. They are cognate; and the fan, at all events, has been made the subject of more mathematical investigation than, perhaps, any other form of mechanism which plays an important part in the world's economies. In the first instance, the diverging nozzle had no application in the arts. After a time it was found that the delivery from a fan was augmented by the use of an evasé chimney. Then it was suggested that the chimneys of locomotives should be made smaller at the bottom than the top. By-and-bye came the ejector condenser; then the diverging nozzle played a useful part in the exhausting apparatus of the Smith vacuum brake; and now in these last days it has been brought into full prominence as a most important adjunct to the steam turbine. A correspondent recently stated in our pages that he was unable to find any information about the proportions that should be given to nozzles employed in producing a partial vacuum, and we can corroborate his words. As for the diverging nozzle used in steam turbines, the proportions adopted are, so far as we can find out, purely empirical, each maker by trial and error arriving at that form which gives the result most satisfactory to himself. We are repeatedly asked where formulæ for particular designs may be found. As a rule, there are no formulæ of this kind, or if there are, they may not apply to a special case. The reason is, of course, that formulæ printed in a book or treatise can only be either absolutely general, or if particular, then the chances are a thousand to one that they will not fit the precise case for which a formula is wanted. If it were otherwise then all engineering could be carried on by the aid of books. There would be no opening for original skill or thought. Let us, for example, suppose that definite dimensions of the most minute character could be deduced from a mathematical dissertation on the flow of gases through diverging nozzles. It might very well be found that diverging nozzles made on these lines would be quite unsuitable to steam turbine constructive details, but this would not be the fault of the mathematician; he has but one aspect of the question before him. He has to determine what is the form of nozzle which will to the best advantage transform pressure into momentum. What becomes of the momentum subsequently is not his affair, but it is very much the affair of the maker of steam turbines; and thus it is that, as we have said, there is no attempt at uniformity of proportions in the diverging nozzles of the turbines of various makers; and we may add that it is quite probable that the difference in efficiencies due to differences in proportions are after all quite insignificant.

The fan is the second example which we have named of the apparent failure of mathematics to settle proportions. The ruling conditions seem to be so diverse that it is impossible to arrive at any general conclusions. Each set of experiments appears to give results different from those which preceded it, and small alterations in detail affect efficiency in a way seriously out of all rational relation to their own insignificance. Mr. Norris, concluding an interesting record of experiments with mining fans, embodied in a paper read last September before the American Institute of Mining Engineers, says:—"It is hoped that this present paper may awaken interest in this much-neglected subject, as only by the co-operation of many engineers can sufficient data be accumulated to settle the many vexed questions pertaining to the design of a ventilating fan. This desired result may best be accomplished by the publication of the characteristic efficiency and water-gauge curves of various sizes and designs of fans, so that, from the whole, it may be possible eventually to select a fan best suited to the particular conditions under which it is required to operate." Unfortunately, it is almost certain that the curves asked for would not possess the anticipated utility, for the simple reason that the efficiency of fans is determined almost wholly, as we have said, by minute matters of detail. Mr. Norris's paper supplies an admirable example of this. He gives in detail the results of a series of carefully-planned experiments, carried out with a Guibal fan, 18ft. in diameter, 7ft. wide, with a double intake 9ft. in diameter, and passing as much as 173,000 cubic feet of air per minute, with a half-inch water gauge and a blade tip speed of 5090ft. per minute. The efficiency under these conditions was 17 per cent.; the tips of the blades were bent back to a tangent. But this fan passed 197,000 cubic feet per minute with a water gauge of ·92in., a peripheral velocity of 4976ft. per minute, and a mechanical efficiency of 30 per cent. when the fan

tips were made radial. The alteration as seen in the drawings is quite insignificant.

Finally, we would say to the student that books will never form a substitute for brains. Nothing can be written or printed which will be at once special and universal. Formulæ abound for proportioning girders, but numerous designs will satisfy the mathematical conditions. Furthermore, in engineering as in all else, the world is very far from knowing everything. The modest man, no matter how great his attainments, will always be ready to admit that he has got something to learn. The field of engineering is not restricted, and the advent of each new invention of any importance sends someone to dig in it; indeed, curiously enough, inventions usually seem to have come first, the knowledge of the facts on which they are based has been acquired subsequently. No one thought about thermodynamics until the steam engine was invented. This is probably the reason why so many mistakes are made, and so much money is wasted. Possibly a better time is coming. It is at least certain that not a few successful inventions have originated in thorough appreciation of the practical value of recent scientific discoveries and deductions. The mathematics have come first in these cases at all events. The machine is the result of reasoning on first principles; the enunciation of the principles is not the result of the machine.

ENGINEERS AND IRON.

THE information which is at our disposal points one way. The current improvement in the iron and steel trades seems to render it advisable for consumers to arrange for supplies earlier than usual. The custom of waiting until the close of the quarter before renewing quarterly contracts may well this time be abandoned, and requirements ordered at once. Several shillings per ton on some descriptions of material—foundry pigs, for example—may very probably be saved if engineers can make arrangements, speedily, for supplies to last them up to the end of March, instead of as usual deferring their negotiations until the quarterly meetings at Barrow, at Middlesbrough, and at Birmingham, which will not be held until some time during the first fortnight in January. And the same is true of engineering sections of steel, and of some descriptions of manufactured iron, including engineering bars. The circumstance that there are considerable orders in hand and in prospect for structural work of various kinds, including bridge and roofing and gasholder work, is causing an improved demand for sections of iron and steel suitable for such structures. The fact that sales of iron and steel have been none too large for some months, and are only just again beginning to re-assume normal proportions, is calculated to make iron and steel manufacturers desirous to assist the revived demand as much as possible by granting as good terms as practicable when asked to do so. Whether they will be equally as obliging in a few weeks' time, when the improvement has further strengthened, is doubtful. We think that the improvement has come to stay. It has been slowly gaining strength, as our columns have shown, for several weeks past; and the weekly letters from the various districts, which appear as usual in the present issue, indicate a further onward tendency, both in demand and in values. Even after deducting the influence of the better reports from the United States, and speculative influences at Glasgow, both of which elements in the situation may prove to be only temporary, there yet remains sufficient expansion of legitimate demand to form a solid basis to go upon when indulging the hope that the trade depression, which has now lasted three or four years, is at length giving way to better times. That prices of engines, and machinery, and tools ought to be gradually advanced to correspond with the rises in iron and steel and fuel, should these last continue, is an opinion to which our readers would do well, not with suddenness, but with due caution, to give effect.

STEEL MAKING IN THE UNITED STATES.

THERE is nothing like bankruptcy for getting at commercial facts. So much has been said and written about the relative costs of making iron and steel in this country, the United States, and Germany, that the first accounts of the Receiver for the Susquehanna Iron and Steel Company are not without interest. We learn from these accounts that from December 1st, 1903, to October 15th, 1904, the earnings were £163,000, the working expenses £159,000, and the net profits only £4000. There were 1210 hands employed, whose wages reached £58,000. Altogether this does not appear to be a superlatively successful undertaking. The amount of capital invested is not stated, but it must be very large.

OIL FUEL BURNERS.

IT has long been known that the complete combustion of oil fuel is far from easily effected. But apart from this there are interesting practical difficulties which have to be overcome. Water is almost always present in crude oil, sometimes to such an extent that the flame is extinguished, but it is not so generally known that fine sand in the oil must be provided for. The exhaustive experiments carried out by the United States Navy Department have given this sand question prominence, and reference is made to various forms of strainers. We are told that the insertion of a blind-wire gauze gasket in the joints of the oil pipe, while having the merit of simplicity, yet proves as a working method to be unsuitable owing to the long time required to unbolt the joints to take the gauze out for cleaning. A much more satisfactory plan is to employ appliances devised on the lines of strainers used in other classes of marine work. An advantage of this type of construction is that the wire gauze is placed on the inside of a perforated metal basket. This metal basket is of such shape that it can be readily removed and replaced by a fresh and clean one. The gauze used for oil strainers should not be too open, and should be formed of brass wires of probably a width of mesh work equal to about half of the width of oil orifice in the burner. When it is remembered that some of the crude oils are not nearly so fluid as thick treacle at moderately low temperatures, it will be seen that the straining of them is not free from difficulties.

DOCKYARD NOTES.

THE Terrible did not, as so many people imagine, return to England from Wei-hai-Wei at a fixed speed of 12 knots odd. That was her average. She did, for instance, 15 knots across the Indian Ocean. On the 1902 return trip also there were considerable variations in her speed.

THE whole of the Apollo class will, it is said, soon disappear from the Navy List. The Brilliant—which was always the best steamer of the lot—has already been condemned. These cruisers were "flyers" in 1890 and thereabouts, and used to make easily the then extravagant speed of 18 knots at sea. To-day none of them can touch that, and some are doing pretty well if they exceed 15. It is obvious, therefore, that they cannot chase the foe, or scout satisfactorily for 18-knot battleships. Their armament of two 6in. and six 4·7in. renders them equally unable to engage anything. When the reorganisation is complete, our cruisers will be as follows:—Armoured: The Drake, Cressy, Devonshire, and County classes. Unarmoured: The Powerful, Diadem, and Gem classes. The Encounters, Minervas, and Edgars will be kept on for a time, but chiefly for training purposes, &c., rather than for war. In battleships it is stated that the Admirals, Colossus class, and Conquerors will be dispensed with. The Trafalgars and Sanspareils will be retained for harbour duties, &c., till the Sovereigns can relieve them.

IT has been proposed that new propellers shall be fitted to the Powerful and Terrible. Both these ships are still good for their original 22 knots, and with better propellers it is thought that 23 knots might be reached. Though without vertical belts they have extremely thick decks, and they are so large that they will stand a great deal of hitting. The small damage done to the Gromoboi indicates that a large casemated cruiser can survive a great deal of fire. True, the Gromoboi has a belt, but it is less effective as a shot stopper than the Powerful's deck, and its width is very small.

A RATHER absurd agitation is being got up about the supply of coal to Russia during the war. Japan, if she has had less, has had a great deal of coal also, and the restrictions which allow German ships to carry Welsh coal while our ships may not is not good for trade. The cry raised in some quarters for stricter regulations to prevent our manufacturers from competing with foreign firms in supplying munitions of war to the combatants is also rather ill-timed. So long as the law that those trading in contraband do so at their own risk and without benefit of the flag is upheld, more is hardly required. If a possible enemy must not be supplied in peace time we shall presently get the ethics that no Power with which we are ever likely to be engaged in hostilities must be supplied with any war material, a thing that a few people—who do not manufacture war material—already urge.

THE report that the King Edward damaged her decks at her gun trials is correct. The deck aft was depressed 5in. by the fire of the 9·2's.

THE new German battleships have hitherto been named by the Kaiser alone, and he has always kept the secret closely till the day of launch. Now, however—either because the imperial talent for name-finding is wearing thin, or because of the birth of a new sentiment—the "N" class are to bear the names of predecessors. The first was named Deutschland, and two of the others will be called Koenig Wilhelm and Kaiser. The name of the lost Groesser Kürfurst may also possibly be perpetuated.

LIGHTING STANDARDS.

A SERIES of tests is being carried out at the Westminster Testing Laboratory under Mr. Lancelot Wild, chief electrician of the Electrical Testing Laboratories, Limited, in order to obtain independent figures of the maximum horizontal and angular intensities and the mean hemispherical intensity of different forms of electric and gas lighting for interior and street use. The results obtained from the street lamps, in addition to being expressed as above, will also be expressed in foot-candles, so as to give lighting intensity at various distances. Lamps of all descriptions are being tested, among which may be mentioned flaming arcs, open arcs, enclosed arcs, miniature arcs, the various sizes of Nernst lamps, Bastian mercury vapour lamp, and all types of glow lamps. Gas lighting will be tested on both the ordinary and high-pressure systems. A special high-pressure service has been constructed, and tests will be made of Keith's, Sugg's, and Welsbach intensified lighting systems. The Welsbach, Bray, Lucas, and Wis high-power lights will also be dealt with. There are no fewer than eleven photometers being used, all of which have been made by Messrs. Alexander Wright and Co., and the comparison-box in all cases is the Simmance-Abady-Flicker photometer. The primary standard is the Harcourt pentane lamp, as used by the National Physical Laboratory, and the secondary electrical standard calibrated by that lamp can be perfectly controlled by a Vulcan potentiometer. A special photometer is set apart for the calibration of the secondary standards, and another one for the illuminating power of the gas. A new form of central station photometer is also being used, by means of which a comparison of an electric incandescent lamp can be made with the standard by anyone, as no calculations are necessary. The measurement of the gas used is obtained by a certified Board of Trade meter; the pressure is controlled, registered, and indicated by carefully calibrated instruments. One of the most interesting instruments in use is the street photometer. An actual pentane standard of light is used, and an Abady-Flicker photometer. The instrument is mounted on a small carriage, and can be moved about quite easily.

OBITUARY.

CHARLES BELK.

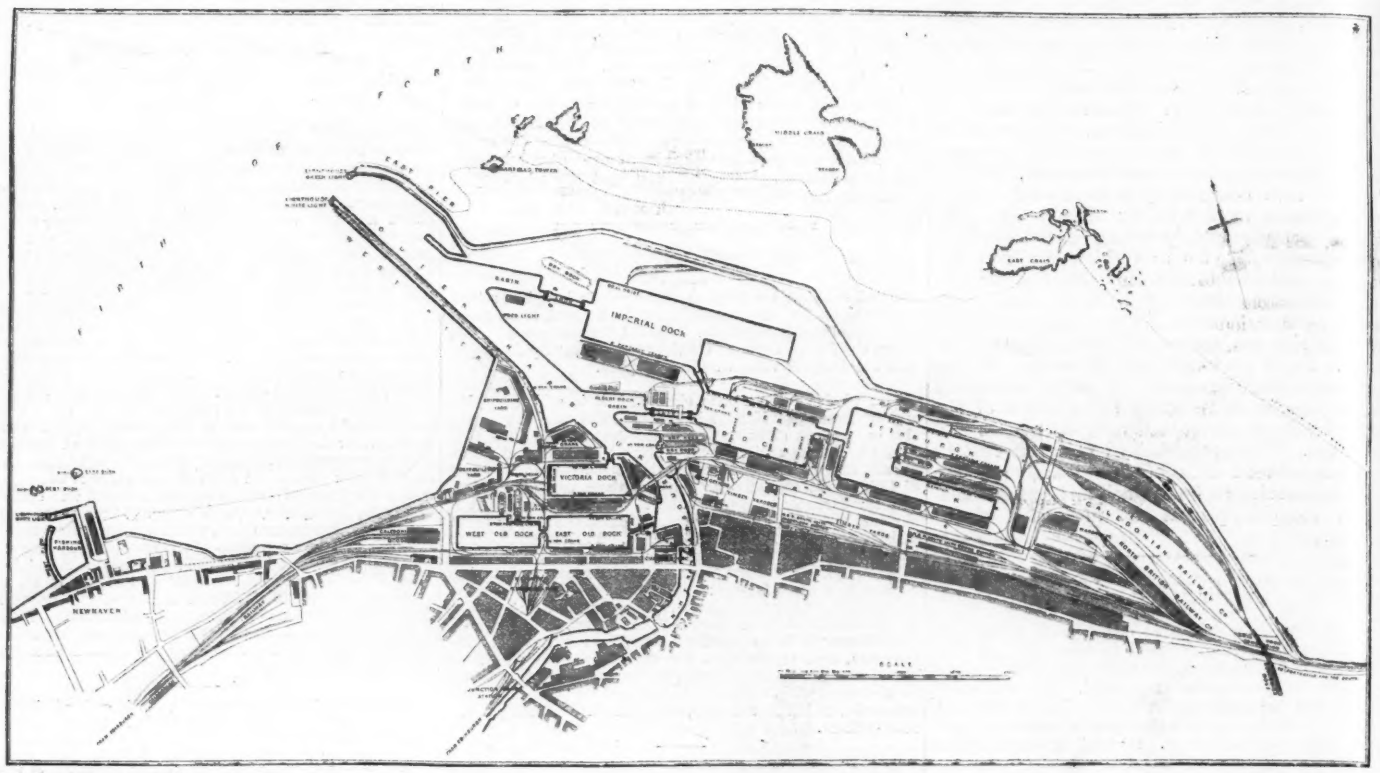
MUCH regret is expressed in Sheffield at the death of Mr. Charles Belk, of Holmwood, Silverhill, Ecclesall, which occurred on Monday last. Mr. Belk was senior partner in the firm of Messrs. Roberts and Belk, silver and electro-plate manufacturers, Furnival Works, Furnival-street, one of the oldest and best known of Sheffield establishments in this business. As Master Cutler, in 1885, he had as his chief guest at the Cutlers' Feast the late Lord Randolph Churchill. During his year the International Property Convention was held at Rome, and Mr. Belk attended. At that convention an important proposal was made on behalf of Great Britain with a view to international recognition of the principles of industrial dealing, more particularly relating to goods bearing a false indication of origin. The proposal was adopted. Mr. Belk was a witness before the Committee on Depression of Trade, and in every great matter affecting the commercial interests of Sheffield took a prominent part. His interest in the Cutlers' Company was of long standing, and was continued after his retirement from the office of Master. In 1894 he presented the Company with two handsome tablets, on which the names and dates of past Masters are engraved, so that for the first time an authentic record was established of all who had filled the high office. Three years later he presented a handsome mace, which has been used ever since at the installation ceremony of the in-coming Master Cutler. Mr. Belk was a member of the Master Silversmiths' Association, Guardian of the Assay-office, and, up to his death, chairman of the Sheffield Committee of the Royal Metal Trades' Pension Society. Mr. Belk, who died in his sixty-fifth year, was in failing health for some considerable time, and three years ago felt it necessary to retire from active participation in business.

WE regret to have to announce the death, on November 16th, at South Bethlehem, Pennsylvania, of Dr. T. M. Drown, the President of Lehigh University, and the secretary for many years in its earlier days of the American Institute of Mining Engineers. Dr. Drown, who was a leading authority on the chemistry of iron and steel in America, had been a member of the Iron and Steel Institute since 1886, and took part in the meeting of that society in New York last month.

ENGINE-SHAFT BEARINGS.—The fifth meeting of the forty-ninth discussion session in connection with the Manchester Association of Engineers took place on Saturday evening, Mr. Alfred Saxon, the president, in the chair. Mr. William Turner, of Manchester, read an interesting and practical paper on the "Adjustments and Alloys of Engine-shaft Bearings." At the outset, he said he had been prompted to write the paper by an article which appeared in THE ENGINEER, under date October 16th, 1903, on "The Bearings of Naval Engines," by "A Naval Engineer." He pointed out the lack of proper adjustment of bearings in the Royal Navy, and the results arising therefrom, and strongly advised the adoption of phosphor bronze in place of white metal. White metal was all right for tunnel shafting, and similar work, because it yields and spreads itself out, and accommodates itself to the varying alignment of the ship; but it ought to have no home in the bed-plate of an engine if good workmanship can be had. In a properly finished phosphor-bronze bearing the surface contact, at the proper parts, should be as good as mechanical skill can make it. No skill can bed a shaft so well as its own running will do in time, but the mechanic's work on a bearing ought to approach as near as practicable to this perfection. Then no heating will follow, except from other causes, which can be guarded against. Tin was very undesirable in an alloy for bearings, but it cannot be done without. Copper must be hardened by tin, but there is no reason for putting more of the latter in than was necessary for that purpose. He pointed out the cause of unnecessary friction and how to avoid it, and discoursed on the erection of engines, and the method of dealing with their fixing or adjustment. He concluded by quoting, with approval, a leading article appearing in THE ENGINEER of the 11th November, as to the additional instructions issued by the Admiralty for steam trials on a modern warship. Several members took part in the discussion, in the course of which the views of Mr. Turner on white metal, as compared with phosphor bronze, were sharply criticised, and it was contended that under certain conditions white metal was quite as suitable, if not more so, for bearings as phosphor bronze, while others advocated "genuine" gun-metal as being the best. Mr. Turner was heartily thanked for his paper.

THE JUNIOR INSTITUTION OF ENGINEERS.—A large number of the members, accompanied by the President, Mr. W. H. Lindley, and the chairman, Mr. Samuel Cutler, jun., visited recently the Central Station of the South Staffordshire Mond Gas—Power and Heating—Company at Dudley Port, and the most recent additions to the Birmingham Corporation Gasworks at Nechells. At the former they were received by the managing director, Mr. Howell; the resident engineer, Mr. Lindop; and other gentlemen. Mr. H. A. Humphrey, the company's consulting engineer, was prevented at the last moment from being present. The station, the first as yet erected, occupies a position which is practically the industrial centre of gravity of the district, comprising 120 square miles in South Staffordshire, over which the company has powers. There are to be four units, each of eight producers, and the first unit, together with a complete set of spare towers, is now ready for working. Each producer is capable of gasifying one ton of fuel per hour throughout the day and night. Steam is raised by means of Climax vertical boilers arranged for burning small coal with forced draught, and also for firing by gas. Fraser and Chalmer's compressors for putting the gas under pressure for distribution were seen in the machinery house, and also two vertical Westinghouse gas engines driving various electric motors used in connection with the plant and for lighting. The pipes for conveying the gas to Wolverhampton, Walsall, and intermediate towns, have been laid by Messrs. John Aird and Sons, and are mostly of the steel-locking type made by Mephan Fergusson. At the Birmingham gasworks, on behalf of the engineer-in-chief, Mr. Henry Hack, by whom the whole plant has been designed and carried out, the members were welcomed by Mr. W. Chaney and Mr. T. R. Murray. A fine example of an inclined retort installation was seen here, the house being 324ft. long by 114ft. wide, with semi-circular "arch-rib" roof of one span. There are four benches of retorts, each bench consisting of thirteen settings, eight retorts per setting, and all heated on the regenerative principle. A carburetted water gas plant, capable of producing over six million cubic feet of gas per day, was also seen. In connection with this plant there are four oil-storage tanks of steel of 60ft. diameter, 25ft. high, and 1,760,000 gallons total capacity. The whole of the manufacturing and purifying plant at Nechells is now in course of duplication, and well advanced, and will, when finished, complete the scheme of works, as originally designed, viz., for ten million cubic feet of gas per day, excluding water gas.

DOCK EXTENSIONS AT LEITH



"THE ENGINEER" SWAIN SC.

NEW DOCK, LEITH

THE newest and most important accession to the dock system of the port of Leith—the Imperial Dock—although at that time simply nearing completion so far as general construction was concerned, was described briefly, along with a somewhat comprehensive outline of the origin and development of the older docks, in our issue for July 22nd, 1898. What was then said of the newest dock along with its predecessors, both as to wet docks and those for graving purposes, as well as the facts given in our issue for March 14th, 1902, should make the view we now give of the Leith dock system as a whole of intelligible interest. The figures and data given thereon are quite self-explanatory, but a few particulars are needed with regard to the recent and somewhat belated formal opening of the new dock.

The Imperial Dock itself has virtually been complete and partially available to shipping during the past two years or so. Water was first admitted to the dock on March 7th, 1902, and shipping for the first time accommodated on May 6th, 1902, since which at least 100 vessels per year of the largest class frequenting the port have used the new dock. These events of importance in the history of the undertaking, which, with the scheme of foreshore reclamation, &c., have occupied altogether about nine years, were, however, only rendered possible by taking advantage of the aid afforded by the adjacent Albert Dock, and of a new passage-way, which was formed to connect it with the new dock. The separate, new, and more direct entrance from the channel, with its commodious basin, although constructed, was not then cleared of that portion of the East Pier stretching across the outer end of basin, which had been left intact to form a dam during the formation of the dock and basin. The task of removal has proved a much more arduous and difficult part of the work than had ever been contemplated, owing to the cropping up of an unsuspected ledge of exceedingly hard rock just in what may be called the critical corner of the entrance basin and along the line in which a jetty had to be constructed.

The facts that the dock proper and its quays have long since been accomplished things—as already described in THE ENGINEER—and that shipping has been extensively accommodated in the indirect but designedly alternative way above referred to, viz., *vid* the Albert Dock entrance and connecting passage-way, conjoined to the difficulties just spoken of, have made it less pressingly imperative that the special and direct entrance should be pushed on to completion, in spite of all obstacles.

Considering, however, that on occasion of "good tides" lately as much as 24½ft. of water at low, and 31ft. at high tide mark have been noted above the present level of the obstructing rock ledge spoken of, it has been felt that, without relaxing efforts to reach the maximum and designed depths of 25ft. and 30ft. respectively, the time had come for an official "rounding-off" of the undertaking, one of the greatest of its kind achieved in the East of Scotland, involving the expenditure of three-quarters of a million sterling.

The ceremonial opening of the Imperial Dock took place on the 8th inst. On that date, and amidst an immense throng of spectators, the s.s. Peveril, belonging to the fleet of George Gibson and Co.'s continental traders, made an entry into the new dock through the entrance basin and lock leading direct from the main channel. Ex-provost Aitken, who was associated with the inception and initiation of the project of the new dock works, was constituted a kind of master of ceremonies, and both on board ship and at the luncheon which followed, the names of Sir A. M. Rendel, M. Inst. C.E., long the consulting engineer to the Leith Dock Commission, and of Mr. Peter White, M. Inst. C.E., the Commisssioners' able resident engineer and dock superintendent, came in for meed of mention and honour.

THE DANISH TRAIN FERRIES.

IN connection with the proposal to establish ferry steamers for the transport of trains in the English Channel service, the accompanying engraving illustrating the working of train ferries in Denmark is of interest. It may be remembered that a commission, representing the South-Eastern and Chatham and Northern of France Railway Companies, visited Denmark two years ago in order to observe the working of the cross-channel train ferries in connection with the Danish State Railways. In Denmark this method of ferrying rolling stock under conditions very similar to those met with in the English Channel has been carried on since 1882. It was stated at the time of their visit that the Anglo-French deputation were so impressed with what they saw that the adoption of the principle of ferrying across the Channel is being seriously considered in regard to the passenger traffic, as well as the transit of merchandise.

DANISH TRAIN FERRY BOAT

The most important Danish ferries are across the Little Belt, between Fredericia and Strib, 1¾ miles; across the Great Belt, between Nyborg and Körsor, 25 miles; across the Ore Sound, between Helsingor and Helsingborg, two miles; and across the East Sea, between Gjedser and Warnemünde, 40 miles.

The ferry boats are capacious vessels, about 300ft. in length, and of 100ft. beam. On the upper deck is laid one or more lines of rails, according to the traffic exigencies of the ferry in question. When a boat is equipped with only one line of way, the latter is laid down the centre of the vessel; when there are two lines of way, these diverge from a single track at the bows and stern and follow each side of the vessel. Boats reserved for the transit of goods wagons are furnished with as many lines of way as the deck can accommodate converging into one at the bows and stern respectively. Only the luggage vans and sleeping cars of the passenger trains are ferried across the Little Belt and Great Belt, but between Helsingor and Helsingborg the corridor carriages are also transported, while on the long Gjedser—Warnemünde ferry two through express trains between Berlin and Copenhagen daily in each direction, composed of five first and second-class corridor carriages and two vans by day, and three or four sleeping cars by night, are carried over the sea. Locomotives are not transported. The ferry stations are furnished with a number of special docks for berthing the vessels, the outer row of piles of which the docks are constructed being connected with the inner by means of spring buffers, for the purpose of fenders. A travelling platform, with one line of rails, connects the lines of way on shore with those on board, and is lowered or raised to coincide with the level of the stern of the boat, according to the state of the tide. No hydraulic or power machinery is employed for raising and lowering the platform, which is effected by means of counterweights contained in the lattice-work arch. The carriages are simply pushed on board through the stern by a small shunting engine, and hauled off again through the bows.

During the voyage the wheels of the carriages and wagons are scotched, and if the sea is at all rough the vehicles are further steadied by bolting them to the metals with screw couplings. The working of the Danish train ferries is accomplished expeditiously, a few minutes at each port sufficing for the shipment and unshipment of trains. The passage of the Little Belt, 1¾ miles across, is now usually done in ten minutes, a striking contrast to the "ten hours, tacking without ceasing to gain the shore," which it cost Mary Wollstonecraft on her return home from Norway in 17?. The voyage across the Great Belt, which is of the same length as that from Dover to Calais, occupies one and a-half hours, while the 40-mile passage between Gjedser and Warnemünde is performed in little over two hours. With the help of powerful ice-breakers, railway communication between the islands is hardly ever interrupted in winter. "Car ferries," as they are termed, are common in America, and some long voyages are made on the lakes in this manner. They are also met with in Switzerland, notably on Lake Constance. All these ferries, however, ply on comparatively quiet inland waters, and are confined to the transportation of merchandise.

An argument used against the introduction of ferry boats in the Channel service is that it is extremely doubtful whether these boats could make the passage during the boisterous weather which so often prevails in the Straits of Dover. But the unbroken success attending the working of the Danish ferries would appear to refute that argument, inasmuch as seas fully as rough as those experienced in the Channel crossing are encountered in the passage of the

Great Belt and East Sea. The convenience of the ferry system becomes of great importance when the consideration of time and cost is taken into account. The delay and expense of loading and unloading mails and baggage is altogether avoided, and the goods traffic is not subjected to any breaking of bulk. Where the goods traffic is concerned, without the "floating railways" the Danish State lines could not possibly contend with the very severe sea competition that exists on all sides.

A NEW REVOLUTION INDICATOR.

We illustrate below the Milner speed indicator, as constructed by the Speed Indicator Company, Limited, Watling-street, E.C. The principle involved is so simple that it can be explained in a very few words. In the lower part of the instrument is a little fan, driven by a belt from the engine or machine whose speed has to be ascertained. In the current of air despatched by this fan is suspended a light vane mounted on a spindle pivoted in jewels, which carries a hand traversing a dial. This spindle carries a small counter-balance weight, which always tries to place the hand at zero.

When the fan revolves the current of air presses on the vane, and pushes it before it until the movement of the balance weight further from the vertical, provides sufficient resistance. Now the force of the current from the fan depends on the rate at which the fan revolves, and it is only necessary to calibrate the instrument, which is very easily done, and the hand will indicate on the dial the number of revolutions per minute made by the fan and belt pulley, and, with this, the speed of the engine, dynamo, or other machine to which the instrument is applied. The advantages claimed are that the design and method of working are such that a perfectly accurate indication of speed can be obtained. The slightest variation of speed is shown, owing to the extreme sensitiveness of the indicating portion. There being no mechanical connection between the driving and indicating

MILNER'S SPEED INDICATOR

portion, a perfectly steady needle is obtained. There being no wearing parts, when once adjusted, it will remain constant. Owing to the extreme simplicity of construction, the instrument cannot possibly get out of order. The dial can be turned to face any position. A special and novel feature of this indicator is that it can be made to suit any speed. It can be fixed in any convenient position. It becomes useful for the most delicate machinery, there being no appreciable power required for driving. It is perfectly free from magnetic influence.

We believe that nothing is claimed here that is not true. The instrument is sensitive to the last degree, and it is clear that there is nothing to get out of order.

An objection has been raised to the effect that a variation in the density of the air affects the accuracy of the indications. In a cold room the speed shown will be greater than in a hot room. Careful investigation has, however, shown that the maximum error introduced in this way barely reaches 5 per cent., and in practice it is negligible, because in a power-house, for instance, the temperature is always pretty nearly the same. Other causes of error, such as the friction of joints, affect the indications of the normal centrifugal tachometers, and cannot be allowed for; but nothing is easier than to make a small addition or subtraction to the reading of the Milner instrument for every 5 deg. or 10 deg. of range of air temperature. The instrument has had a very full trial at the General Post-office, and at the works of Messrs. Davey, Paxman and Co., Colchester, and appears to have given complete satisfaction. The principle is elegant, and seems to have been carefully applied in practice.

"SALTLEY" LATHE CARRIER.

The accompanying illustration shows a new lathe carrier which is manufactured by Messrs. Thos. Smith and Sons, Saltley Mills, Birmingham. In general design it is exactly

the same as the old type of carrier, but the special feature is that it is fitted with a patented packing attachment. By this means the carrier is always ready for immediate use, and no time is lost in fitting packing. The carrier is made throughout of steel, and is manufactured in different sizes, varying from ¼in. to 3in.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE ADHESION OF STEAM WAGON WHEELS.

SIR,—In your issue of November 25th we notice a letter on "The Adhesion of Steam Wagon Wheels," signed by "Alp."

We do not know whether we are the firm alluded to, but the question the writer raises is one of considerable importance, as he testifies, not only to owners and users, but to the manufacturers.

It is, however, hardly fair to cast the blame of the matter wholly on the manufacturers, as "Alp" appears to do. It is really a question of regulations, and so long as the Local Government Board insists that wagons shall be fitted with wheels having smooth tires, it is difficult to see how in view of other conditions to be considered in the design of wheels, the matter of slipping can be got over satisfactorily.

In several cases we have supplied wheels with diagonal strakes across the tire, but the spaces between these strakes are necessarily small, otherwise there might be risk of damage to the roads, when not covered with snow; and in any case there would always be risk of interference by the authorities for infringement of the regulations as to smooth tires. If the spaces between the strakes are reasonably small, and diagonal to the tire, the wheel becomes practically smooth tired. But on the other hand, these spaces quickly become filled with snow and mud, which, to some extent at least, neutralises their effect.

Several different devices have been introduced by different makers at different times to overcome this slipping difficulty. These devices generally take the form of an attachable snow shoe. We ourselves have used this method, and have supplied, in several cases, a separate tire, with well-spaced cross pieces riveted on to it, and which is adapted to be bolted round the wheel, over the tire proper. This device answers very well while the wagon is upon the snow, but of course when the snow is thin and the road soft beneath it there is risk of cutting into the surface of the road.

Besides this, there is the difficulty, with the continual tendency to increase the width of tire, of providing snow shoes to fit every case; and in this the owners do not assist the makers.

We think it is scarcely fair to expect manufacturers to hold a stock of snow shoes adapted to fit every wagon which they may have turned out in the last four or five years, and owners always wait until the necessity is upon them before they take any steps to procure snow shoes.

With the amount of snow we usually get in England, we do not think that, on the whole, the question is such a serious one, though it may appear so to the owners at the moment. Seeing the great economy to be effected by the use of steam wagons, over horses, in ordinary times, we think it should be considered a special circumstance when the road conditions are so bad that the wagon cannot go out; and it should be noted that this is not by any means whenever there is snow on the ground, but only in certain conditions of that snow. On these occasions it would be well, perhaps, if the owners would give the time to overhauling their wagons, since we fear that a great many users grudge any time spent on this most desirable occupation.

Summing up the whole matter, we would point out that the wagon is not precluded from running, even with smooth tires, whenever there is snow, but only under certain conditions. That under these conditions the use of snow shoes will enable the wagon to run. That non-slipping wheels can be made, but that manufacturers are precluded from fitting such wheels by existing regulations.

JOHN I. THORNYCROFT AND CO., LIMITED,
Hogarth-lane, Chiswick, (Publicity Department),
London, W., REGLD. H. L. MARKHAM,
November 30th. Manager.

H.M.S. TERRIBLE.

SIR,—In reply to "Perplexed," the solution of the Terrible mystery is simple enough.

First of all, she did not make a trip out and back in 1902. She went out in 1900, served her commission, and came back in 1902. Her enormous expenditure of coal was principally due to leaky steam pipes, &c. The ship was fitted with the regulation pipes to stand the 150 lb. pressure of her immediate predecessors, and the 250 lb. pressure of the Bellevilles made these give out. Hence increased coal had to be burned to make good the losses from this cause. Probably dirt was present also, but primarily the blame, such as it was, rested with the Admiralty design. She was an experimental ship built in the days when little was known of Belleville practice.

For her present cruise she carried substantially the old nine-year old boilers. Practically nothing was done to these except a thorough cleaning. The auxiliary service boilers were renewed to a considerable extent. Great care was expended upon the steam pipes, all connections being made perfect. Three new fusible plugs were fitted, and during the entire trip only four blew out or required replacing.

The 1904 trip was in no sense an experimental one; the ship was practically a stoker's training ship; 75 per cent. of the stokers were absolutely raw, and of the remainder comparatively few were Belleville trained. On the other hand, the chief engineer had a wide Belleville experience extending from the Sharpshooter; and the scientific spreading of the coal, according to the Belleville instructions, was enforced. This and the care of the steam pipes explain the coal economy. There were no stoking indicators or such like devices employed. The 1904 record is in no way abnormal for Belleville ships; the abnormality consists in the fact that a ship without economisers has done as well as many ships with them.

The greater speed for less horse-power mystery is due to a variety of causes. Indicated horse-power was carefully kept this trip, it is not known whether it was so carefully kept on the 1902 trip back. The trim was rather more favourable at the average speed than in 1902. The engines are in rather better condition. I have had an opportunity of examining the ship's log and find that all the published figures are correct.

There is one slight error in your article, however. The Terrible's Bellevilles never gave any trouble at any period of her career; all the bother she experienced in early days was with the steam pipes. The fact that these are now jointed to stand the necessary pressure, accounts for the absence of all mishaps in modern Belleville ships as compared with the troubles experienced a few years ago.

Portsmouth. NAVALIS.

SIR,—Your correspondent is not the only one "perplexed." The figures he gives are so remarkable that I must ask him to say how he got at them. On the 1902 voyage, the ship was at sea 39 days, and during this time she burned 959 tons of coal for culinary purposes. That is 24 tons 12 cwt. per day, or 55,104 lb. Her complement is, I think, 700. Therefore, over 75 lb. of coal per day was expended in cooking for each member of the crew and officers. Apparently while in harbour about half the crew must have had their meals on shore, as the consumption of coal for cooking dwindles to about one-third of that burned at sea.

May I venture to suggest that a considerable naval economy might be effected by reorganising the galley fittings of H.M. ships? A SON OF A SEA COOK.

Liverpool, November 29th.

REACTION IN A DIVERGING NOZZLE.

SIR,—I am obliged by Mr. Neilson's reply to my inquiry, which, however, he has left unanswered. I did not ask for a formula, but how well-known formulæ are to be applied.

The effect of reaction is to produce pressure. On what area is that pressure exerted? Thus, if I have a diverging nozzle 1in. in diameter at the smallest and 3in at the largest part, what is the effective area on which the back pressure is exerted? Is it ·7854 of a square inch? I take it that there is some lateral pressure exerted against the walls of the nozzle. If there is not, what is the use of the nozzle? If there is, as the walls are inclined, we must have, for obvious reasons, a thrust effect.

I fancy, further, that if Mr. Neilson will think over the matter again he will see that the reaction effect cannot possibly be independent of the velocities. If, for example, the discharge velocity was 5000ft. per second and the nozzle velocity in the opposite direction was also 5000ft. per second, then there could not be any recoil effort; just in the same way, if the buckets of an impulse water wheel move at the same rate as the water impinging, there is no work done by the wheel. My excuse for troubling Mr. Neilson is that, though I have a little library of steam turbine books and pamphlets and papers, English, French, and German, I can find no definite information about the diverging nozzle, to which so much importance is attached. TESTOR.

November 27th.

AIR EJECTORS.

SIR,—Your correspondent "Inquirer" should at once discard the annular jet, for it is an instrument of enormous capacity for wasting his compressed air, consuming, for example, when full open, about as much as would issue from a plain jet 1¼in. diameter, and probably only giving about one-fifth the result attainable from a well-proportioned solid jet working in combination with a "blower," or "trumpet pipe," designed in accordance with certain principles which govern the action of jets and the flow of fluids.

If "Inquirer" will state the volume of air required to be exhausted per hour, and also the dimensions of the "tapering funnel," it will enable me to say whether the latter is of efficient design or otherwise, and to give proportions for the jet, and for a new trumpet pipe, if such be necessary. As an alternative, he might endeavour to see one or more of the numerous steam-jet blowers in use at many of the ironworks in the Coatbridge district. A few minutes' study of the best designs would yield considerable information. W. A. GRANGER.

Palmer's-green, London, N., November 26th.

ACETYLENE GAS ENGINES.

SIR,—In reply to a letter signed by Mr. Frank Eames in THE ENGINEER of November 18th, we enclose you list of our acetylene gas engines, which we have made, and have a great many working satisfactorily in different parts of the country, pumping water and sewage on farms and estates, which are lighted by acetylene gas.

ALF. DUCGIEL AND CO., LIMITED.

Leeds, November 22nd.

AWARDS AT THE ST. LOUIS EXHIBITION.

We have received the following additional list of awards to British exhibitors at the St. Louis Exhibition, supplementing the list published in our impression for November 11th. The total number of awards secured by this country now stands thus:—

Grand prizes	142
Gold medals	250
Silver medals	170
Bronze medals	134
Total	696

DEPARTMENT OF LIBERAL ARTS.

Group 26.—Models and Plans of Public Works.

Bronze medal.—W. H. Wheeler and Co.

DEPARTMENT OF MANUFACTURES.

Group 37.—Decorative and Fixed Furniture.

Gold medal.—Ch. Mellier and Co.

DEPARTMENT OF ELECTRICITY.

Group 71.—Applications of Electricity.

Gold medal.—Charles F. Wilkins (collaborator to Nalder Bros. and Co.).

DEPARTMENT OF TRANSPORTATION.

Group 74.—Railways.

Grand prize.—The London and North-Western Railway Company.
Bronze medal.—John Jones.

Group 75.—Plant and Material for Mercantile Marine.

Gold medal.—The Ocean Steam Navigation Company.

DEPARTMENT OF AGRICULTURE.

Group 80.—Fertilisers.

Grand prize.—The United Alkali Company, Limited.

Group 84.—Vegetable Food Products.

Gold medal.—The Joint Exhibitions Committee, Kingston Jamaica.

Group 87.—Farinaceous Products and their Derivatives.

Gold medal.—Allen and Hanburys, Limited.

Group 94.—Fermented Beverages.

Silver medal.—E. Dyer and Co.

DEPARTMENT OF MINES AND METALLURGY.

Group 116.—Ores and Minerals.

Gold medal.—The British South Africa Company (Rhodesia).
Silver medal.—J. C. Burrow (collaborator to the Home-office).

Group 118.—Metallurgy.

Grand prize.—The Monk Bridge Iron and Steel Company, Limited; The Farnley Iron Company, Limited.

THE BRITISH ASSOCIATION OF WATERWORKS ENGINEERS.

THE ninth winter meeting of the Association will be held at the Geological Society's Rooms, Burlington House, W., on Saturday, December 10th, 1904, when the chair will be taken at 11 a.m. The business will comprise:—

(1) The minutes of the ninth annual general meeting, held at Hull, June, 1904, will be read and put for confirmation.

(2) Ballots will be taken for the Council and officers for 1905-6, and for new members and associates.

(3) Reading of paper entitled "The Appleton Extensions of the Warrington Corporation Waterworks," by George Mitchell, and discussion thereon.

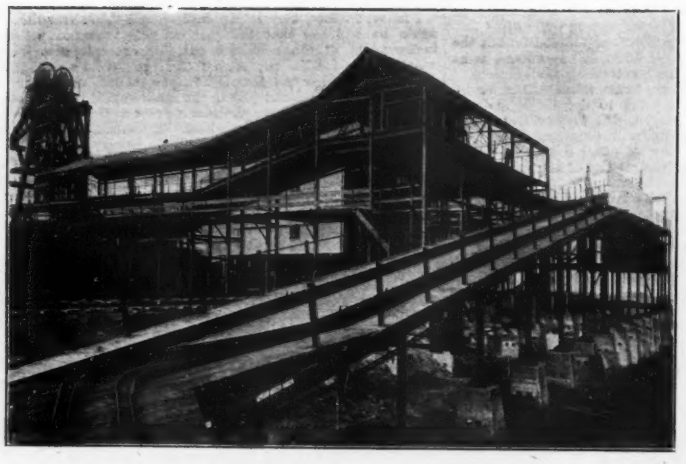
(4) Reading of paper entitled "Supply of Surface and Underground Water to Towns," by Frank Latham, Penzance, and discussion thereon.

(5) Reading of paper entitled "Notes on Electrically-driven Pumping Plant for Water Supply, and Storage of Water under Pressure," by J. Hutton, Scarborough, and discussion thereon.

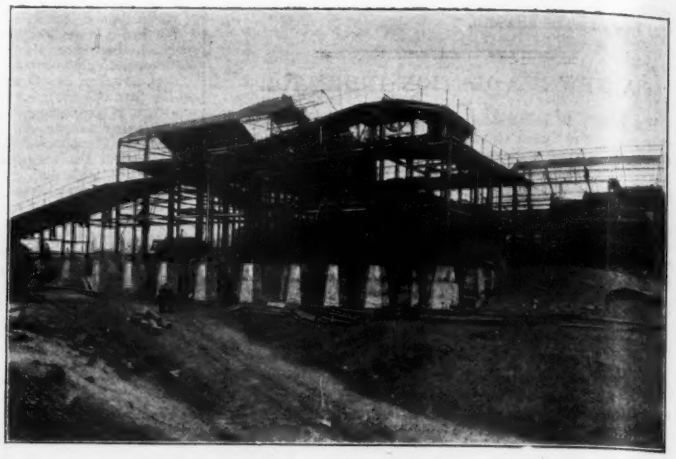
(6) Presentation to Dr. Kenna of gift subscribed by members and friends who took part in the tour in Belgium.

SCREENING PLANT, THRYBURGH COLLIERY, KILNHURST

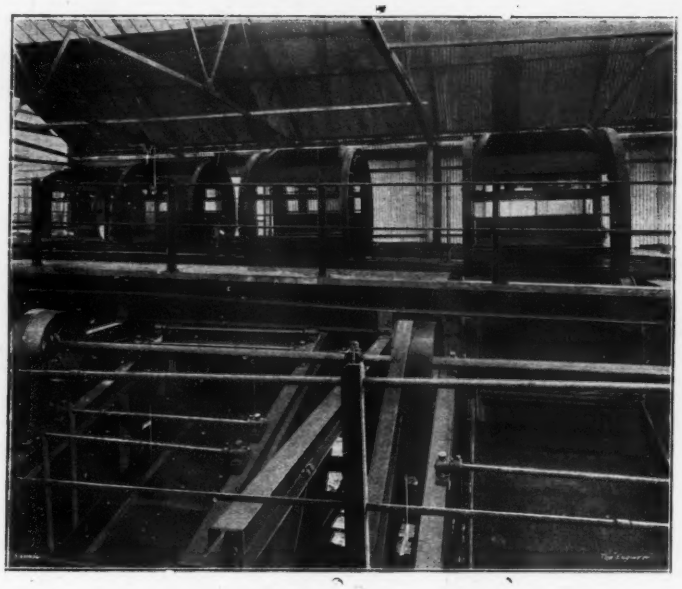
GRAHAM MORTON AND CO. LIMITED LEEDS, ENGINEERS



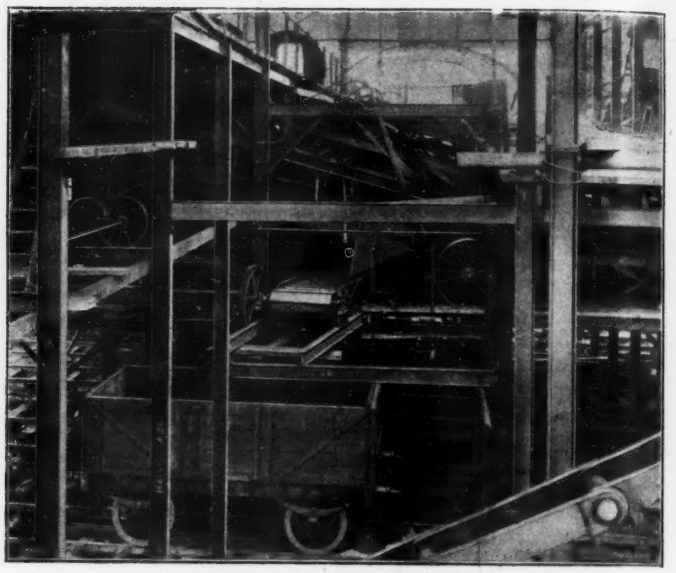
EMPTY TUB DISCHARGE RAMP



GENERAL VIEW OF STAGING



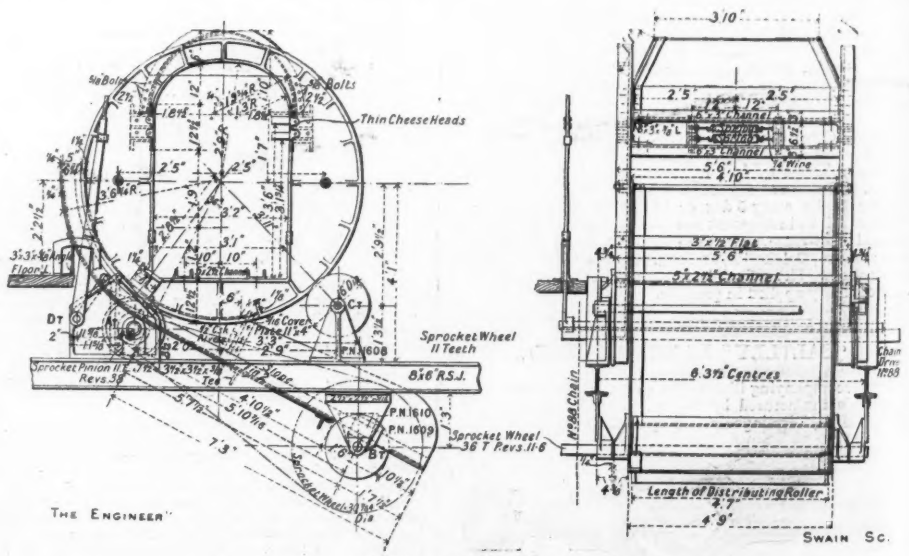
TIPPLERS AND JIGGING SCREENS



DISCHARGE FROM PICKING TABLE

COAL-SCREENING PLANT.

A SCREENING plant for the Thryburgh Colliery, Kilnhurst, near Rotherham, has recently been completed by Messrs. Graham, Morton and Co., Limited, Leeds. The plant comprises a screen-house, tipplers, jigging screens, picking belts, with lowering arms, raising and lowering gear with balance weights, slack creepers, and gantries for conveying the tubs to and from the screen-house. The old method of handling the coal consisted in the use of double-decked cages containing two tubs on each deck. The tubs that came off the top deck were lowered by means of a second cage attached to the pulley rope, and the speed at which the cage descended was regulated by a brake. They were then run to the edge of a fixed screen and there tipped, the small coal falling between bars spaced the correct distance apart, so that all the fine coal was separated from the rest. The new plant consists of three inclined tub gantries leading from two pit shafts with a screening and picking-house between. Gantry No. 1 has two floors, thereby allowing all the tubs of the double-decked cages to be dealt with at the same time. On leaving the two decks of the cages, the tubs run down by gravity to the bottom of a steep sloping gantry, and are drawn up by means of creepers, which are formed of 12in. links bolted together to form a continuous chain, with rollers pitched every 3ft. The engaging attachments for the tubs are 6ft. apart, and at the top they converge on one plane, where they pass over a weighing machine which automatically records the weight of each tub. Then they fall by gravitation to one of four tipplers, where their contents are discharged automatically, revolving rollers turning the tipplers round. As the tubs come round, a catch comes into action which prevents them from falling out. The next full tub coming along pushes the empty one out of the tippler. The empties continue their course through the screening-house, and return to the high-level pit by means of gantry No. 2, which is used solely for the returned empties, and is provided with two floors, to suit the double-decked cages. The third gantry deals with the tubs from the low-level pit, the full ones being brought up one side, and the empties being returned by creepers similar to those on No. 1 gantry. The tubs are then directed to any of the four tipplers by means of points and crossings, which are operated either by hand or foot. This portion of the plant presented rather serious difficulties, as there are two classes of tubs in use, each having a different wheel gauge. In the screening and picking-house there are four automatic revolving tipplers, constructed so as to deal with the two classes of tubs. The contents are discharged down shoots that feed on to a fluted roller, which distributes the coal evenly over the full width of the jigging screens through which it is sized. The jigging screens, which are 26ft. long by 5ft. 6in. wide each, are arranged immediately underneath the tipplers. Two of these are placed in position for dealing with hard coal, one for soft coal, and the other for gas coal. There is a secondary screen, with perforated plates on the underside of each main screen, their object being to separate the nuts and peas into distinctive hoppers. The screenings are collected by means of receiving hoppers in position on the under side of the secondary

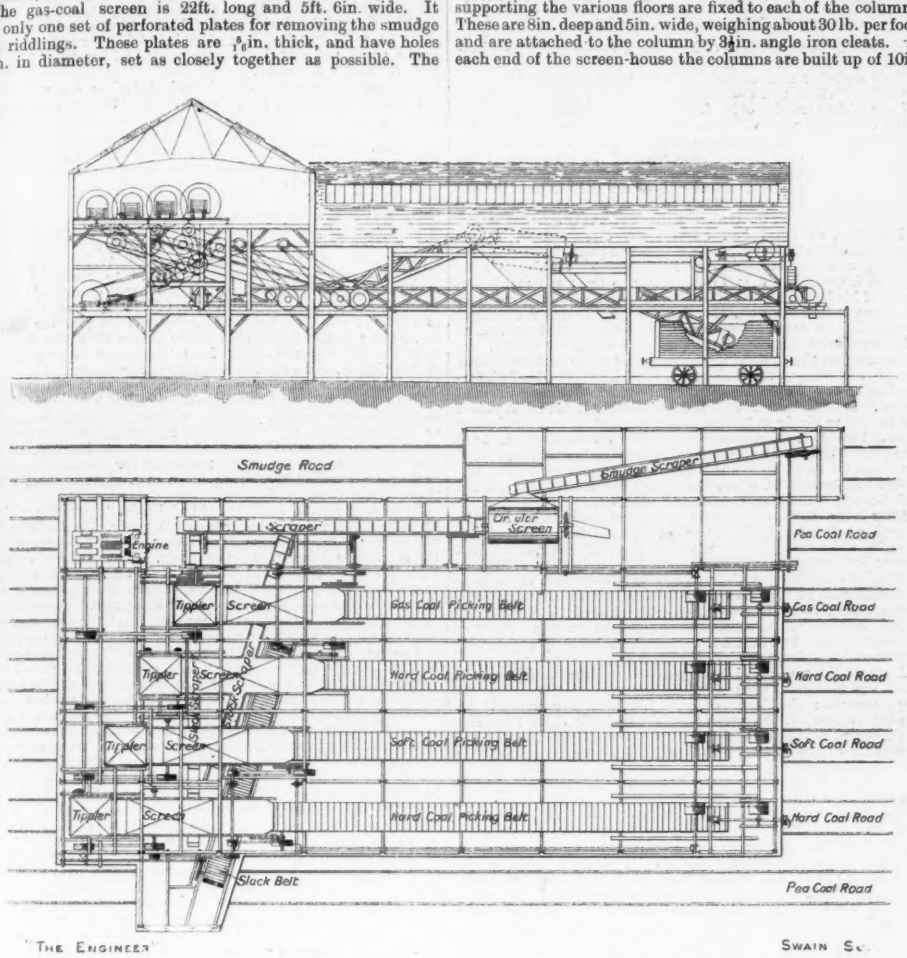


DETAILS OF TIPPLER

screens. Large coal passing over the perforations of the jigging screens is delivered on to picking belts that carry it over the radial arm, raised or lowered by suitable gear, into the railway wagon. Each belt is fitted with a hinged lowering arm, 17ft. long, so that the fall of coal from the belts into the trucks is reduced to a minimum. These arms are operated by suitable gearing provided with open and cross belts, and are balanced so as to absorb a minimum amount of power when in operation. The above gives an outline of the general arrangement of the plant, but the description would not be complete without giving further details of the construction. Commencing with the machinery in the screening-house, the tipplers are built of cast iron rings, suitably stayed and cross-braced by means of tie bolts, and to them are attached ⅜in. delivery plates for delivering the coal into the tippler shoots, so as to reduce breakage to a minimum. These rings are supported on smaller cast iron rings of about 16in. diameter, mounted on 3in. diameter steel shafts, and provided with pedestals and collars. The shafts are operated by malleable iron driving chains and cast iron sprocket wheels. The tippler shoots for conveying the coal to the jigging screens are built up of ⅜in. bottom plates, bent to shape, having ⅜in. side plates attached to the former by 3in. angles. The bottom plates are further stiffened by 3½in. tee

irons. Each tippler shoot is furnished with one set of cast iron distributing rollers carried on a 2½in. diameter shaft, and supported by brackets on the side plates of the screen. The rollers are driven from the tippler driving shaft with malleable iron chain and cast iron sprocket wheels. There are four jigging screens, so arranged as to deal with hard, soft, and gas coal. The two hard coal screens are constructed in a similar manner, and are 28ft. 6in. long and 5ft. 6in. wide. The framework consists of 12in. by 3½in. channels, supporting the perforated plates and the dead plates. The former has holes 1 5/16in. diameter, set as close together as possible, and providing a total screening surface of about 75 square feet. The surface of the perforated plates in the secondary screens already referred to is arranged thus: (*a*) Twenty-five per cent. of the surface is provided with plates having holes ⅝in. diameter for taking out the smudge; (*b*) 30 per cent., with plates having holes ⅝in. diameter to take out riddlings and pea nuts; (*c*) 25 per cent., with plates having holes ⅝in. in diameter to take out any of the riddlings that may have passed over the pea nut screen. The remainder are dead plates. The screen for dealing with soft coal is 26ft. long by 5ft. 6in. wide, and is similarly constructed to the other screens. A system of hoppers on the underside of the secondary screen deals with the smudge riddlings and pea nuts, and outlet shoots deliver to the cross conveyor.

The gas-coal screen is 22ft. long and 5ft. 6in. wide. It has only one set of perforated plates for removing the smudge and riddlings. These plates are 5/16in. thick, and have holes 5/16in. in diameter, set as closely together as possible. The



GENERAL ARRANGEMENT OF COAL SCREENING PLANT

framework is similar to those of the jigging screens; and a hopper is suitably fitted on the underside.

The hard and soft coal jigging screens are provided with two pairs of excentrics, having 5in. stroke. The gas coal screen is driven by a single pair of excentrics. The shafts for driving the screens are 4½in. diameter, and on each shaft is keyed a 3ft. diameter cast iron fly-wheel, weighing 5 cwt. The angle of the screens is 15 deg., and the rate of work is 100 jigs per minute. On the underside of the jigging screens is a tray conveyor of 36ft. centres and 3ft. 6in. wide, similar to the large picking belts, but with only two strands of chain. The conveyors, which are of the push-plate type, are 42ft. 6in. between centres, and their widths 30in. and 24in. respectively. One is for collecting the smudge and riddlings from the hoppers placed below the jigging screen, and the other for delivering the small coal into the revolving screen. They are constructed, with steel channels, flanges and bottom plates, in the form of a trough, the return chains being supported on a lattice braced framework built up from the channel runners. Each conveyor is provided with two strands of 6in. pitch chain, of thin and thick links bolted together. To the thick links are attached the push plates, arranged at intervals of 2ft.

Besides the push-plate conveyors described, there is another one, 41ft. between centres, 12in. broad, and built up in a similar manner to those which collect the smudge from the hoppers, and deliver the small coal into the revolving screens. At this stage the coal is delivered into the revolving screen, 5ft. 6in. in diameter by 11ft. long, with a capacity of screening about 40 tons of small coal per hour. The framing for the screen is mounted on a steel shaft 14ft. long by 3½in. diameter, supported at each end by suitable pedestals. The perforated plates composing the screen are 5/16in. thick, and at each end are dead-plates ½in. thick, firmly attached to 1in. diameter wrought iron arms. Three sets of these are arranged inside the screen, and thoroughly secured to cast iron bosses keyed to the main shaft. Beneath the revolving screen a receiving hopper is in position for collecting all the smudge which passes the perforated plates in the screen, finally delivering it into scraper conveyors. A delivery shoot passes the riddlings into the railway wagons. The gearing for driving the entire plant consists of one main driving shaft about 25ft. long and 5½in. diameter. From this shaft are tapered the various drives to the picking belts, jigging screens, scraper conveyor, revolving screens, and the raising and lowering gear for the lowering arms on the ends of the picking belts. All the shafts are steel, and are carried on cast iron pedestals with brass bushes, cast iron stools, and brackets of cast iron. The lowering arm is driven by a 3½in. steel shaft, which runs the whole length of the screening house. Each set of lowering gear is operated by means of 18in. diameter wrought iron pulleys having 18in. faces, which drive similar pulleys by open and cross belts. The latter pulleys are mounted on 2½in. diameter shafts, on which are fastened 6in. diameter cast iron worms, gearing with cast iron worm wheels firmly keyed on to 3in. diameter shafts, running at right angles and having cast iron drums. One of the drums contains the chain for the lowering arm, the other contains the chain for the balance weights, which are provided with suitable guides.

The structure for supporting the plant is substantially built, and a short description of the columns and joists will be interesting. The columns for the main screen-house and for the tippler floor are built up of 8in. by 6in. rolled steel joists 24ft. long, and having base plates ½in. thick, attached to the flanges of the columns by 7/8in. gusset plates, these being further stiffened by 3½in. angles. The foundation bolts are 2in. in diameter and 3ft. long, and pass through both the base plates and the angle iron stiffeners. Cross joists for supporting the various floors are fixed to each of the columns. These are 8in. deep and 5in. wide, weighing about 30 lb. per foot, and are attached to the column by 3½in. angle iron cleats. At each end of the screen-house the columns are built up of 10in. by 6in. joists; and for supporting the lean-to roof over the revolving screens the columns are of 8in. by 6in. rolled steel joists 20ft. long. The roof consists of three principals, 22ft. span, and built of 2½in. by ⅜in. tee-iron rafters, with struts of 2in. by 2in. angles, and flat bar ties of 2½in. by 5/16in. flat steel. Over the picking belt floor is another roof having five principals with a span of 44ft. They are constructed with 4in. by 4in. by ½in. tee irons 20ft. long, which are securely tied and strutted by flats and angle struts, each member being attached to the rafter bar, and the main tie bars with ⅜in. gusset plates. This roof is built up of angle iron purlins, tee iron astragals and corrugated iron sheeting, firmly attached to framing supported by steel columns; a suitable provision is made for the skylight, a width of 5ft. being left on each side of the apex.

The roof over the tippler floor is constructed of six built-up steel principals of 51ft. span. The rafter bars, 6in. by 6in. by ½in. tees, angle struts of 3in. by 3in. by ½in. angles, and the tie bars are 4in. by ⅜in. flat steel. The angle iron purlins for this roof are of 3in. angles and 56ft. long. Light is admitted by skylights 5ft. wide, and running the entire length of the roof. Power for working the plant is obtained from a horizontal steam engine connected to the main driving shaft by double-leather belting. It is interesting to note that the whole of the plant was built in two months, and some idea of the size can be gained by stating that it covers an area of 21,300 square feet, and is supported by 193 stanchions, whilst the total weight of the structure without machinery is 300 tons. There are 22,876 lineal feet of 9in. by 3in. planking used in the flooring and 20,180 superficial feet of corrugated sheeting used in the roof and sides. The engineers for the foregoing work were Messrs. J. and J. Charlesworth.

THE Government of India have referred to the Bengal Chamber of Commerce a proposal to adopt one Indian standard time of 5½ hours in advance of Greenwich, and one Burma standard time of 6½ hours in advance of Greenwich. The Royal Society, which has been urging the Government of India to consider the subject, would preferably recommend the adoption of two standard times in India; one of five hours advance, and one of six hours, there being a dividing line down the middle of India across which the step of one hour in nominal time occurred.

THE INSTITUTION OF CIVIL ENGINEERS.

DISTRIBUTION OF ELECTRICAL ENERGY.

AT the ordinary meeting on Tuesday, the 22nd November, Sir Guilford L. Molesworth, K.C.I.E., President, in the chair, the paper read was "Distribution of Electrical Energy," by John F. C. Snell, M. Inst. C E. The following is an abstract of this communication:—

The paper deals first with the attitude of the Legislature towards the electrical industry, and recites some of the points of the 1882 Electric Lighting Act, which retarded the progress of electrical development. It then deals with the improved clauses under the 1888 Electric Lighting Act. Reference is made to the removal of restrictions upon undertakers which would be effected by the Electricity Supply Bill, promoted by the Board of Trade in the last session of Parliament, and a hope is expressed that this will soon become law. Mention is also made of the falling-in of the leases of borough tramways, and the effect of electrical traction upon the output and load-factor of the generating stations. The author then describes the various systems by which electricity is at present distributed, including direct-current two and three-wire distribution; direct-current high-tension generation and low-tension distribution; single-phase, two and three-phase currents, high-tension generation and low-tension distribution; three-phase high-tension and low-tension direct-current distribution.

After dealing with the limits of pressure as defined by the Board of Trade, and the results of the work of the Engineering Standards Committee in settling upon standard periodicities, the systems of supply are more thoroughly criticised, and the single-phase system is set aside as being inapplicable for general supply, as is also the direct current high-tension system. The author is of opinion that the distributing systems which are likely to be adopted in the future are:—(1) Direct-current, two or three-wire, for small districts. (2) Single-phase high-tension for railways. (3) Two-phase high-tension generation and low-tension distribution—for existing single-phase systems of general supply. (4) Three-phase high-tension generation and direct-current low-tension distribution—for existing direct-current systems in large districts, and for railways of short length. (5) Three-phase high-tension generation and low-tension three-phase or six-phase distribution—for entirely new and large districts.

Diagrams accompanying the paper demonstrate the economical radii of supply by direct current at 500 volts for different loads transmitted and by the high-tension sub-station method, the result being that above the undermentioned distances the high-tension method is more economical, viz.:—

Kilowatts.	Economical radius.
250	1·6 mile.
500	1·25 ,,
1000	1·06 ,,

With regard to the effect of storage at sub-stations, the author believes that storage will be more largely resorted to in the future; and figures are given in support of this view. He then proceeds to discuss the economical limit of pressure for high-tension supply by underground cables, and gives curves to show that for general purposes, in Great Britain, 6600 volts is, approximately, the economical pressure. The effect of the cost of insulation of extra high-tension cables is also discussed. The paper next deals with the cost of overhead transmission of high-tension currents, and reasons for fixing upon a pressure of 20,000 volts in this country are given.

As to the cost of supply, the ideal figure given by Colonel Crompton in 1894 is stated to have been surpassed. A new ideal figure is given by the author, based upon further experience gained in the past ten years, and he predicts the costs which are likely to be charged to various classes of consumer.

Turning to transmission lines, a description is given of the practice adopted in extra high-tension underground cables, and the risks which have to be guarded against. The mechanical and electrical construction of overhead lines for extra high pressures is also dealt with.

The paper then enumerates various classes of sub-station, covering static transformers for three-phase low-tension distribution; static transformers with rotary converters for direct-current distribution; and synchronous or induction motor generators for direct-current distribution at the higher periodicity. Descriptions follow of the various sub-stations erected by the author, with curves of their outputs, and particulars of their efficiencies. The various methods of distributing energy at low pressure are classed as follows:—

I. *Conduit or draw-in system.*—(1) Bare copper-strip systems, strained and unstrained; (2) cables insulated by india-rubber, vulcanised bitumen, or other dielectrics drawn into stoneware casings, Callender-Webber bitumen casings, fibrous conduits, cement casings and cast iron or wrought iron pipes.

II. *Buried or solid system.*—(1) Vulcanised bitumen, dialite or other insulated single cables, laid in iron, stoneware, or wooden troughing, and surrounded by molten bitumen or pitch; (2) concentric cables, paper insulated and lead covered, laid in the same manner; (3) single-phase or concentric cables, each protected by its own sheathing of steel tapes or wires, laid direct in the ground.

The relative merits of these systems are fully discussed, and a curve is given showing the respective capital costs of the systems. The author then deals with the systems of distribution adopted in tramway construction, and their relative advantages and disadvantages. The question of fusing the general network, and the fixing of section boxes is gone into fully; the author deciding against fuses, except in concentric networks, and strongly advocating the use of section boxes for sub-dividing the network.

The paper concludes with some particulars of the supply of electrical energy to short and long-distance railways. The author believes that a modification of the present third-rail system will remain with short-distance railways, and that improved methods in the application and control of single-phase currents will be adopted for long-distance railways.

PASS LIST, OCTOBER EXAMINATIONS, 1904.

Studentship—F. A. Battle, E. G. Carty, R. H. Collingham, R. D. K. Curling, P. Davies, S. F. Deacon, C. H. Dobbs, V. Elkington, R. M. Francey, R. A. Frank, W. N. Goodman, H. R. Greene, L. C. M. Greenwood, H. W. Hague, J. C. Holland, A. R. Homan, H. Hughes, H. D. Jones, H. McLaren, H. F. Mason, F. O. Medworth, A. Milliken, J. W. Minshull, C. P. H. Newcombe, A. Ohlson, O. Owen, H. H. Oxley, L. Page, E. G. Parker, J. Parkinson, J. A. Paterson, A. O. W. D. Pinson, E. E. Rigold, J. M. Robertson, A. Robinson, J. Robinson, W. C. Rubie, M. F. Ryan, S. H. Sellers, A. T. Shores, H. C. Sims, J. M. L. Smith, F. A. Sutton, F. N. G. Taylor, A. C. Ward, H. S. Wilkinson, G. Yeoman.

Associate Membership (candidates examined in London): Whole examination.—A. G. Beaumont, A. T. Best, A. Bromly, F. H. Brunt, B. W. Bryan, F. G. Carron, H. S. Culverhouse, W. H. Dickenson, E Dobson, A. S. Ellerton, E. McC. Fitt, W. Foulis, H. N. Funnell, R. G. Garrow, G G. Glyn, R. G. Hannington, F. E. Harrison, C. J. Henderson, J. W. Hipwood, R. F. Kesting, T. D. Key, G. P. Knowles, P. A. Leitch, J. M. Mackay, G. MacLachlan, G. E. Morgans, W. Nairn, W. H. Owston, W. Plant, L. E. Poynton, J. E. Rogers, B. Royce, C. H. Sandeman, F. B. Shaw, E. Speechly, J. W. Spiller, P. T. Steinthal, H. L Stevens, W. Sweetman, G. H. Tarver, W. A. Turnbull, G. H. Whitaker, R. A. Whitson, C. S. Wilson, D. H. Wilson.

Section B of Part II. (previously passed in Part I. and Section A of Part II.).—J. Ramsay, N. P. P. Sandberg, E. S. Warmington.

Part I. and Section A of Part II.—F. W. Balston, H. A. R. Edwards, F. B. Gibbard, E. Y. Harrison, H. C. Hilton, H. E. Morrall, E. S. Pink, J. B. Rowe, A. While, H. F. Wilkinson.

The results of the examinations held in India and the Colonies will be announced later.

PERMANENT WAY FOR TRAMWAYS.

AT the meeting of the Rugby Engineering Society, held on November 3rd, Mr. Chas. T. Taylor read an interesting paper on "Permanent Way for Tramways." The author, in his opening remarks, pointed out the necessity for laying a good track, because in lengthening the life of a track considerable saving was obtained in the subsequent capital outlay, and this is always one of the most important factors for consideration by the engineer. Mr. Taylor puts the cost of a single track of 4ft. 8½in. gauge at about £6000 per mile. Its life may be taken from ten to fourteen years, depending upon the service, and if a mean of twelve years is taken, then every year the sum of £500 per mile of single track must be earned over and above the fixed charges for maintenance and sinking fund. Every year of life added to the track, therefore, effects a large saving. The rail is the most important part of a track, and the author considers that the head should be of such a section that it will provide maximum vertical and lateral stiffness, and that the profile of the head should be such that it does not interfere with the general traffic, and also that the total width should be as narrow as possible. There seems to be a difference of opinion as to the correct width and depth of the groove to be adopted, but as this is controlled by the wheel flange, the author gives 1¼in. as the width of groove most suited to the climatic conditions of this country. This allows the use of a wheel flange ⅞in. thick on straight work and curves with a greater radius than 75ft., and it also reduces the capacity of the groove for grit, stones and mud. Should the radius be less than 75ft., it is advisable to have a groove a little wider, so as to reduce the friction and flange wear. The lip of the rail must be made sufficiently strong to support the ordinary vehicular traffic, and also a little lower than the tread, as the latter naturally wears away quicker. The height and strength of the lip must be increased on curves, as there is a tendency for the wheels to ride, and consequently increased friction and wear on the wheel flanges. The web of the rail should be so placed that its centre is as near as is practicable below the tread, so that the resultant of the forces from the rolling load of the car and the lateral pressure of the flange shall fall well within the base, and thus reduce the tendency to tilt. The base must be sufficiently wide to reduce this tilting, and to spread the weight over as large an area of concrete as possible, without interfering with the paving. The author does not agree with the present system of rolling the tread of the rails flat. He prefers to have a slight inward slope of the head, because, apart from the fact that better electrical contact could be obtained, it would also materially increase the life of the rail. On the question of the weight of the rail the author has nothing at all to say.

The chemical composition of the metal used is the next point considered. This, of course, is also most important, and depends to a large extent upon the physical and climatic conditions of the district in which the track is being laid. The earlier rails were made considerably softer than those now employed, and the percentage of carbon has risen from ·35 to from ·5 to ·65 per cent., thus increasing the durability of the rail. This steel will stand a tensile stress of 45 tons per square inch with an elongation of 15 per cent. These tests will vary considerably, depending upon the percentage and weights of the elements used. A table is given in the paper, showing the effect of altering the percentages of the elements employed. This, of course, varies considerably with the weight and percentages of the other elements employed. The effect of varying the proportions of these are :—Manganese in excess causes increase in resistance, softening of metal, flow of metal under traffic; silicon in excess causes increase in density, smooth and close surface when rolled; sulphur gives a long fibrous and seamy metal; carbon and phosphorus in excess give brittleness and hardness, shortness of grain to the metal, liability to fracture under temperature. The following is a fair average percentage of the elements in steel rails of from 90 lb. to 110 lb. weight per yard :—

Carbon	·5 to ·65 per cent.
Manganese	·8 to 1·0 per cent.
Phosphorus not more than	·06 per cent.
Sulphur " "	·05 per cent.
Silicon " "	·15 per cent.

The British Standards Committee recommend that the length of the rails be 36ft., 45ft., or 60ft. long, and 36ft. for curves. At one time it was considered necessary to have short rails, as they gave better facilities for allowing for expansion. It is now generally recognised that it is quite unnecessary to allow as much for expansion as was customary, and rails of much greater length are now generally adopted. The author deals with the question of fishplates at some length, and considers that formerly these were rolled with a much too obtuse angle at the shoulder; thus the rail acted as a wedge, and a bad joint resulted. Owing to the fact that a more acute angle is now adopted, the efficiency of the fishplate has been greatly increased. They are also being made longer and stiffer now than formerly, and the Standards Committee recommend that they should be made of the same material as the rails. The paper ends with a few interesting remarks on foundations and paving. The former should consist of at least 6in. of Portland cement composed of 1 part of cement to 6 parts of broken stone and sand. The author considers that "the best way of laying the foundation is to put the 6in. layer of concrete in as truly to level as possible, but from ½in. to 1in. lower than the finished level of the rail flange. After this has set, the rails should be put in position and brought to a true level by cement packing at the joint, and two or three intermediate places on a 30ft. rail. Two men should then be set at work, one on each side, to pack the space between the rail flange and concrete bed. The packing should be composed of one part of granite chips or shivers that will pass through a ¼in. mesh, two parts sand and one part Portland cement, the whole to be slightly damped before packing and well watered afterwards through a rose or nozzle." The paper is interesting and clearly written.

LAUNCHES AND TRIAL TRIPS.

TRYST, steamer; built by, Ailsa Shipbuilding Company, Limited, Troon; to the order of, Mr. W. A. Grainger; dimensions, 185ft., 28ft., 14ft. 3in.; engines, 14½in., 24in., 40in. by 36in., pressure 180 lb.; constructed by, D. MacColl and Co., Limited, Belfast; trial trip successfully carried out in Belfast Lough, November 17th.

ELSA, steel screw steamer; built by, Tyne Iron Shipbuilding Company, Limited; to the order of, Messrs. August C. Mohr and Sons; dimensions, 335ft., 48ft. by 28ft.; engines, triple-expansion, 24in., 39in., 66in. by 45in., pressure 180 lb.; constructed by, North-Eastern Marine Engineering Company; a mean speed of 11 knots was attained; trial trip, November 17th.

SIERRA BLANCA, steel screw steamer; built by, David and William Henderson and Co., Limited; to the order of, Messrs. Thompson, Anderson and Co., Liverpool; dimensions, 3700 tons gross register; engines, triple-expansion, 24in., 40in., 67in. by 45in.; constructed by, builders; launch, November 19th.

ARGOSY, steel screw steamer; built by, Messrs. Thomas Dobson and Co., Hessle; dimensions, 151ft., 24ft. by 11ft. 9in.; engines, triple-expansion, pressure 180 lb.; launch, November 21st.

CAMBRIA, cable steamer; built by, Swan, Hunter and Wigham Richardson, Limited; to the order of, Telegraph Construction and Maintenance Company, Limited; dimensions, 300ft. by 37ft. beam; engines, triple-expansion; launch, November 22nd.

ETTON, screw steamer; built by, Messrs. Ropner and Son; to the order of, Messrs. H. Samman and Co., Hull; dimensions, 331ft., 47ft. 6in. by 22ft. 6in.; engines, triple-expansion, 1100 horse-power, pressure 160lb.; constructed by, Blair and Co., Limited; launch, November 22nd.

PERLAK, tank steamer; built by, Fijnoord Shipbuilding and Engineering Company; to the order of, the Royal Dutch Petroleum Company; dimensions, 240ft. by 42ft. by 20tt.; to carry, 2400 tons of oil; engines, triple-expansion, 21in., 33in., and 55in. by 36in., pressure 180 lb.; constructed by, builders; a speed of 10·9 knots was attained, and everything worked satisfactorily; trial trip, November 22nd.

CLAN MACNAB, turret steamer; built by, William Doxford and Sons, Limited; to the order of, the Clan Line Steamers, Limited; dimensions, 385ft., 50ft. by 29ft.; to carry, 7000 tons cargo; constructed by, builders; launch, November 23rd.

ALBION, turbine steam yacht; built by, Swan, Hunter and Wigham Richardson, Limited; to the order of, Sir Geo. Newnes, Bart.; dimensions, 270ft., 34ft. by 20ft., and tonnage 1260 tons yacht measurement; engines, turbine; constructed by, the Hon. Charles A. Parsons at Turbinia Works; the vessel has been built from the designs of Sir William White; launch, November 24th.

DANSBORG, screw steamer; built by, Blyth Shipbuilding Company, Limited; to the order of, Mr. C. K. Hensen, Copenhagen; dimensions, 297ft. and 43ft. 2in. beam; engines, triple-expansion, 22in., 36in., 58in. by 39in., pressure 160 lb.; constructed by, North-Eastern Marine Engineering Company; the engines worked very smoothly, and the trip proved entirely satisfactory; trial trip, November 27th.

GLASGOW UNIVERSITY.—LORD KELVIN AND OTHER SCIENTISTS.

LORD KELVIN, on the 29th of November, was installed as Chancellor of the University of Glasgow, in succession to the late Earl of Stair, and thereafter a distinguished list of graduands received at the hands of the new Chancellor the honorary degree of Doctor of Laws. The elevation of his Lordship to the chief official position in the University with which he has had so long and honourable a connection, and the presence of Royalty, in the person of Princess Louise, Duchess of Argyll, who was one of the recipients of the honorary degree, gave to the ceremony, which was carried through in the Bute Hall of the University, quite an exceptional interest, and there was a large and widely representative attendance. In intimating the fact of the General Council of the University having so long ago as April last unanimously elected Lord Kelvin Chancellor of the University, several speakers passed brief—because virtually needless—eulogiums on his Lordship. Sir James King thought it no fitting time to endeavour to trace the marvellous career of his Lordship, or to estimate the amount of reflected glory that came to his *alma mater* through his triumphs and his brilliant discoveries. It was needless to attempt enumerating these invaluable inventions which have made the whole world his debtor. By common consent Lord Kelvin was recognised as the first scientist of the age, and almost every nation and every learned body of distinction had bestowed upon him honours the most varied and the most valued. It was, however, questionable whether Lord Kelvin valued any honour so highly or felt so deeply touched by any distinction as he did by his election unanimously and enthusiastically as head of the great University of which he had so long been the ornament. It at least conveyed to him the satisfactory assurance that where he was best known and where he had longest dwelt he was regarded with feelings of the utmost pride and affection.

After being duly installed, and having had presented to him the several graduands, Lord Kelvin addressed the gathering, his remarks, which were listened to with the profoundest attention and respect, being mainly autobiographical and reminiscent of his long connection with Glasgow University, and how he first came to be associated with it. He traced its development as an educational centre, giving many interesting recollections of its various professors, and touched on recent reforms and extensions. Many of his reminiscences had intimate connection with early engineering science and practice.

Amongst those upon whom the honorary degree of Doctor of Laws was conferred were Admiral Sir John Charles Dalrymple Hay, Baronet; the Hon. Charles Algernon Parsons, and M. Guglielmo Marconi. In presenting Admiral Sir John Hay, Professor Glaister, who as Dean of the Faculty of Law discharged this part of the ceremony for all the recipients, briefly recounted the distinguished career of this naval veteran, and concluded that "by reason of his long distinguished, devoted, and active service on behalf of his country as a naval officer, and of his further service in the civil life of the nation, this University claims him most worthy to receive the honour." Presenting Mr. Parsons, the same sponsor traced his educational career and achievements, and proceeded :—His name is perhaps better known in the scientific world as the inventor of the turbine mode of propulsion of vessels, and as the adaptor of the turbine to the generation of electricity. Those who are best competent to judge of the merits of his invention have not hesitated to declare that its adoption generally in ships will revolutionise speed, and that its adaptability to other purposes is far-reaching. For this outstanding meritorious work this University—which was the refuge and support of James Watt in the days when that genius was in the throes of invention of the steam engine—recognising in the steam turbine of Dr. Parsons the most outstanding advancement in the developments of the application of steam power since Watt's great discoveries, desires to indicate its sense of his scientific attainments by conferring on him this degree. Speaking of M. Marconi, and following a *résumé* of that scientist's discoveries and attainments relating to the transmission of electric message signals over very long distances without connecting wires, Dr. Glaister concluded :—"It is more than fitting that the honour which this University now confers on Signor Marconi, who has connected continents by electric communication without wires, should be conferred by one who himself successfully laid the first Atlantic cable, by which for the first time, by means of cable electrically-transmitted messages, the great country of America was brought into electric communication with our own shores."

NAVAL ENGINEER APPOINTMENTS.

THE following appointments have been made at the Admiralty :—

Engineer Commander.—E. H. Ellis, to the Sutlej.

Engineer Lieutenants.—H. T. Canning, to the Firequeen, for charge of Fleet Reserve stores; W. R. Crawford, to the Dryad, for passage home; F. S. Ainsworth, to the Egmont, for the Cygnet; W. Denbow, to the Firequeen, for the Seagull; W. Begg, to the Vivid, for the Pathfinder; E. Groves, to the Firequeen, for the Forward; G. More, to the Pembroke, for the Mermaid; R. S. Pearce, to the Vivid, additional, for the Niobe; T. A. Venning, to the Vivid, additional, for the Encounter; A. G. V. Salter, to the Ariadne, additional, for service in Jamaica Yard; and H. D. Robinson, to the Firequeen, additional, for the Electra; C. W. J. Bearblock, to the Sirius; J. E. Vibert and D. E. Duke, to the Topaze, on commissioning; C. J. Gregg, to the Leander, for the Cherwell, on commissioning, and to the Egmont, for the Cherwell, on paying off; and C. Howle, to the Vivid, for the Arun, to the Leander, for the Arun, on commissioning, and to the Egmont, for the Arun, on paying off.

Engineer, R I.M. —W. C. Constable, to the Vernon and Excellent, for T. and Hyd. courses.

Engineer Sub-Lieutenant.—J. S. Madden, to the Euryalus.

THE Dover Corporation have decided to extend the electric tramways to the suburb of River at a cost of £21,000, the work to be done by the unemployed.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

IN the engineering trades activity is observable in several branches alike on home and foreign account. Overtime is being worked in one or two cases in order to get through contracts before the Christmas holidays. Irrigation plant is being steadily turned out for abroad, and there are several good contracts under execution for electrical machinery. Machine tool makers are moderately engaged. The cycle and motor companies are doing their best to adjust their working conditions to the new era which may be said to have been introduced by the severe cutting of prices which has lately characterised both those trades. The Daimler Motor Company is reducing its capital by selling its undertaking to a new company with the same name, but with a capital of only £200,000. "Drastic rearrangements" are admitted to be necessary by the various cycle and motor firms in consequence of the recent expiry of tire patents.

In the iron trade a continuance of the strength last week recorded can again be reported, and Thursday's market was firm, with disposition on the part of consumers to arrange for supplies ahead. Quotations showed an upward tendency. Marked bars are still at £8, with Earl Dudley's L.W.R.O. brand at £8 12s. 6d. Ordinary common bars are £5 15s. to £6. Galvanised corrugated sheets continue £10 10s. to £10 15s. f.o.b. Liverpool, and are firm, because of a good foreign demand, and because also of the high price of spelter. Plain black sheets, singles, are £6 12s. 6d. to £6 17s. 6d., whilst doubles are £6 15s. to £7, and trebles are £7 7s. 6d. to £7 12s. 6d. Hoop iron is in fair call at £6 12s. 6d. to £6 15s.; nail, rod, and rivet iron is quoted £6 10s. to £6 15s., and gas strip £5 17s. 6d. to £6.

Steel makers are well engaged, and quotations are maintained at : Bessemer billets, £4 5s. to £4 7s. 6d.; Siemens, £4 10s. to £4 15s.; and mild bars, £6 to £6 5s. There is a fair amount of structural engineering work about, and suitable material is offered at, girder plates, £5 17s. 6d. to £6; and angles, £5 5s. to £5 10s. Boilermakers are busy, and are good customers for steel boiler plates at £6 15s. to £7 5s.

As regards crude iron, both forge and foundry pigs are in better request, although values are mostly maintained at their recent level, and in some departments are advancing. Staffordshire cinder forge is quoted 42s.; part-mine, 43s. to 45s.; all-mine, ordinary, 55s. to 60s.; and superior, 75s. to 80s. Agents of Midland descriptions appear less inclined to make concessions than for some time past, Northamptons being quoted 41s. 6d. to 42s. 6d.; Derbyshires, 43s. 6d. to 44s. 6d.; and Lincolnshires, 48s. or a little more. The market is somewhat irregular for Midland sorts, some sellers being able to do better than the foregoing figures. The improved reports from America are assisting matters in this district, and so is the speculative movement in Scotch and Cleveland warrants.

The engine building firms are doing well alike in gas, oil, and steam types for machinery driving, and some good orders are held on Admiralty account. The Bulls Bridge Ironworks have been purchased by Messrs. Joseph Sankey and Sons, Limited, Bilston, who propose to use the works temporary for the manufacture of best sheets, pending the laying down of a modern sheet rolling plant on their Bradley side.

"Gas Engines in Iron and Steel Works" was the title of an interesting paper read recently by Mr. J. H. Hamilton before the Staffordshire Iron and Steel Institute, Mr. H. B. Toy, president, in the chair. The author considers that the most economical boiler is as efficient as the most economical gas producer, but he believes that in daily practice the advantage is on the side of the latter. The maximum efficiency of each was about 85 per cent., but for everyday work the steam boiler would not average more than 60 to 65 per cent., and the gas producer 65 to 70 per cent. But the greatest economy was in the gas engine itself, which, according to public tests, exceeded in thermal efficiency the best figures for the steam engine by about 65 per cent. Electrical transmission had opened up new uses for the gas engine, which already supplied power for operating cranes and tramways, and when the electrification of main railway lines took place the monopoly of the steam engine on land would be invaded. Although the internal combustion motor had nearly ousted the steam engine from the smaller locomobiles, and enabled them to equal in speed the most powerful members of the family, and had at last got a footing on the slow traction engine, yet it was hardly likely that the motor car would grow into a 1500 horse-power locomotive, but rather that the work of the latter would be done by stationary engines, which would not only give energy in return at a three-fold or four-fold rate, but also yield valuable by-products. In conclusion, he commended the use of blast-furnace gas, and pointed out that its complete adoption at the various works would render it unnecessary to consume fuel anywhere except in the blast furnaces. In the course of the discussion Mr. W. Brooks said he had been working gas engines for over twelve months at the ironworks with which he was connected, and he found they gave no trouble and worked well. The author, when replying on the debate, said that gas engines were being used in connection with tramways on the Continent, and were found to be superior to steam engines where the load was intermittent.

A high tribute of praise to Sir William Thompson—now Lord Kelvin—for his electrical researches was paid recently by Dr. W. E. Sumpner when delivering his inaugural address to the Birmingham Section of the Institute of Electrical Engineers. The doctor's subject was the use of iron in alternate-current instruments. He looks forward to the introduction of more delicate instruments for measuring alternate currents.

Engineers and other manufacturers in this district are still paying attention to the "owners' risk" question, with a view to traders obtaining better terms from the railways. A reply on the subject lately received is considered most unsatisfactory, not being a definite and categorical reply on the particular claims sent up. The Standing Joint Committee of the various Midland Chambers of Commerce have therefore instructed their secretary, Mr. G. Henry Wright, to address a further letter to the railway companies. When their reply is received, the Standing Joint Committee, which represents the North Staffordshire, Walsall, Wolverhampton, Worcester, Coventry, Dudley, Kidderminster and Birmingham Chambers of Commerce, will be called together again, and it is anticipated that the Joint Committee will then adopt a report upon the whole matter, with a view to some amelioration of the present conditions being, if possible, obtained.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

THERE was a better attendance on the Iron 'Change on Tuesday last than has been the case for some time past, and there was some buying in most departments. There is every appearance of the tide having turned. Full time is now being worked in the cotton districts, which has improved the demand for textile machinery, and makers now take a more cheerful view of the outlook than they did a fortnight or three weeks ago. Another somewhat interesting feature is the fact that German billets are now approximating to English prices, and, although there are arrivals from both the United States and the Continent, it is thought that generally these are rather on account of old contracts than new business, especially with the States. Meantime, the official advance of 1s. 6d. per ton in Lincolnshire pig iron seems to have led to covering operations, and there has been large buying for some days past. The advance in foundry iron has also reacted on

forge qualities, but there is obviously not the same demand for this class as for foundry iron, and there is not so much doing in consequence of the advance. Derbyshire had rather a sharp rise, and although the announcement of the advance in Lincolnshire pig iron was not unexpected—indeed, it was to some extent anticipated partially by makers, who asked 1s. more before the advance was declared, and it was said on Tuesday that as much as 2s. to 3s. more has been asked in some instances for this class. Even at the advance sellers do not appear anxious to book orders, especially for forward delivery, and in some cases quotations have been withdrawn altogether, offers having to be submitted to headquarters for acceptance. It is observable that during the past week or ten days some thousands of tons of pig iron have gone into store at Middlesbrough, but the accumulations are not large, and the bulk in public stores in the country has not increased to any appreciable extent. Generally, quotations for pig iron delivered Manchester are:—Lancashire, No. 3 foundry, 52s. to 52s. 6d.; Lincolnshire, 49s. 6d. to 50s. 6d.; Derbyshire, 52s. to 53s.; Staffordshire, 50s.; Middlesbrough, open brands, 55s 10d. to 56s. 10d. Scotch: Gartsherrie, 56s. 9d to 57s. 6d.; Glengarnock, 55s. 6d. to 55s 9d.; Eglinton, 54s. 3d. to 54s. 6d. For prompt delivery Heysham, Gartsherrie is quoted 54s. 3d. to 54s. 9d.; Glengarnock, 53s. 3d. to 53s. 9d.; Eglinton, 52s. to 52s. 6d.; No. 3 Middlesbrough is quoted 47s. 6d. f.o.t.; and West Coast hematite, 56s. f.o.t., Barrow. In finished iron and steel buyers show more inclination to purchase, and bars especially are firm. Staffordshire bars are held for £6 5s. to £6 7s. 6d.; Lancashire and Yorkshire ditto, £6 to £6 5s.; hoops, £6 17s. 6d. to £7 2s. 6d.; sheets, £7 5s. to £7 10s.; steel bars, £6 to £6 2s. 6d; English billets, £4 10s. to £4 12s. 6d.; German ditto, £4 2s. 6d. to £4 5s.; hoops, £7 5s. Manufactured copper is in slow request at £80 to £82 for sheets; seamless copper tubes quoted 10d.; ditto brass, 8d.; rolled brass, 7½d.; copper wire, 9d.; brass wire, 7½d.

Since my last letter the weather has taken a turn for the better in the North, and on Tuesday there was considerable interest evinced in the position. There was every prospect of an advance in house coal being declared, and had the change in the weather not come about as it did, it is just possible that more money would have had to be paid for this class. The continued improvement in the cotton industries has caused an increased demand for engine slack, and holders are very firm at last week's prices. Forge and manufacturing coal is in somewhat better request, and demand on shipping account is also pretty good. Full time is now being worked at many of the pits, and large contracts forward are reported in East Lancashire. Ordinary quotations are: Best coal for domestic purposes, 13s. to 14s.; seconds, 12s. to 13s.; common, 9s. to 10s.; steam and forge, best, 8s. 3d. to 8s. 9d.; best engine slack, 7s. 6d. to 8s.; medium, 6s. to 6s. 9d.; common, 4s. 3d. to 5s. at the pits; screened, delivered Manchester Ship Canal, 9s. 3d. to 9s. 9d.; and unscreened, 8s. 9d. to 9s. 2d.

Barrow.—Business in the hematite pig iron trade shows a further improvement on the week, although the amount of business done is not largely in excess of recent experiences. There is a gradual but slow growth in the requirements of consumers, and, by degrees, makers are putting not only more orders on their books, but are increasing the size of the orders, and are booking for forward delivery, which is a a good sign. Prices have advanced in consequence, makers asking 56s. for mixed Bessemer numbers net, f.o.b., and warrant iron holders 56s. net cash, buyers 1s. less. There have been no transactions in actual warrant stocks, which remain, as for a month past, at 12,392 tons, but some excitement has existed in the warrant market, which is a sign that better trade is anticipated in the near future. There are twenty-four furnaces in blast, but it is expected others will be lighted before the close of the year, and most makers are getting their smelting plant ready for work as soon as there is a chance of finding a market for an increased output of iron.

In iron ore the business doing is larger than it has been of late, but there is at the same time an increase in the tonnage of Spanish ores imported on the West Coast. Good native sorts are at 8s. 6d. to 8s. 9d. net at mines, and arrangements are in progress at several of the mines to increase the output of raw material.

There is again more activity in the steel trade to report, but this principally shows itself in the heavy rail department. Orders have been booked at Barrow for the Indian State Railways and for other customers, with the result that the mills are kept on full time night and day. The West Cumberland mills are also busy, and the outlook in this department of trade is very good, with the exception of prices, which remain low in consequence of keen competition; 85s. is the normal price of heavy rails, but continental makers are much below this figure. The plate mills are at work on half time, and it is not probable they will be able to work full time until new shipbuilding orders are booked. Chilled iron castings represent a steady trade, and some business is doing in hoops, but the condition of the merchant steel trade is quiet, and orders are irregular.

Shipbuilders have still hopes of some good orders in the early future, but no new contracts have been placed this week. It is probable the very satisfactory trial of B1 submarine will result in the placing of the orders for the nine others embraced in this year's programme of construction. Brazilian orders are also expected at Barrow, indeed it is generally understood that Vickers, Sons and Maxim, and Armstrong, Whitworth and Co., will divide the orders which are in the market for the Brazilian navy.

Shipping remains very quiet at West Coast ports. Last week the exports included 4640 tons of pig iron, and 6903 tons of steel, making a total of 11,453 tons, in contrast with 11,362 tons in the corresponding week of last year, an increase of 181 tons. The aggregate shipments for the year have reached 664,917 tons, in contrast with 800,218 tons in the corresponding period of last year, a decrease of 135,301 tons.

There is a fuller demand for steam coal and blast furnace coke.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

As was anticipated, the sharp touch of winter has made the house coal trade of South Yorkshire much firmer. People who had been tempted by the exceptional mildness of the weather to delay winter stocks, set about at once on the fall of snow to secure their Christmas requirements, and the continuous stream of coal carts seen in this city has no doubt been paralleled in other parts of the country. Although the accumulations at the pits were found quite sufficient to meet the pressure, coal improved in value almost immediately. Best samples of Barnsley soft coal were advanced to 11s per ton, with every prospect of more being obtained should the weather again become hard. The principal demand at present is for the better qualities; Parkgate, Flockton, and similar seams have been available on easier terms. There is a fair demand, too, for steam coal, in which an excellent business is doing, considering the season of the year. This, of course, is mainly on home account, the export trade being about at an end for this year. Values have weakened somewhat, good hard coal being now obtainable at 8s. per ton.

The Lancashire mills are taking heavy deliveries of small coal, owing to the animation in the textile trades, another cause being the briskness at Batley, Dewsbury, and the adjoining district on reported orders for winter clothing on Japanese and Russian account. Through these and other reasons good slacks are now fetching readily from 5s. 6d. to 6s. 6d. per ton; for inferior sorts there is scarcely any market. Gas coal is in large request under contract, and there is a little betterment reported in coke, though it is not yet large enough to have any appreciable effect on prices. Taken as a whole, the coal business is in a fairly satisfactory condition. Although some of the pits are not working more than three days per week, the majority, it is gratifying to note, afford the men five days' employment.

Much satisfaction is expressed in the Rotherham district at the proposal to connect the Laughton and Shireoaks Railway with that town, which in recent years appears to have been left out of various schemes of railway development. It is expected that Rotherham, in the immediate future, will take an important place as a coal centre, the development of the coal industry being likely to be rapid in this neighbourhood, and railway enterprise is almost certain to follow.

In the iron market there are some indications of a hardening tendency for hematites and pig iron, although the business done does not increase in volume as much as could be desired. The improvement is more noticeable in other districts than in Sheffield, where the output continues in excess of the market requirements, with the result that stocks are not affected, and, indeed, if anything, are larger than they were. Hematites in local demand show, at their present quotations, from 1s. 6d. to 2s. better than three weeks ago, and there is considerable hope that this improvement will be maintained. The current quotations now are:—West Coast hematites, 63s. to 64s. per ton, less 2½ per cent.; East Coast hematites, 58s. 6d. to 59s. 6d.; Lincolnshire forge, 44s.; Lincolnshire foundry, 45s.; Derbyshire forge, 41s.; Derbyshire foundry, 46s.; finished iron bars, £6 5s.

In the heavy trades work continues to be given out with the intention of keeping as many hands employed as possible up to Christmas. The orders in hand will find fair work until then, but unless others come forward in military or marine material it will be necessary to give rather more playtime than either the manufacturer or the workmen desire. Already there is talk of settling down for a week at the beginning of the New Year at several of the large establishments, where no fresh work to any extent has been received of late. The conditions of affairs at the East End is, on the whole, better than at the corresponding period of last year. A very disappointing feature of the heavy trades is the lack of orders in railway material. This department was expected to be fairly busy before the last month of 1904, but it continues in a languid condition. A few colonial orders, with considerable requirements from the Indian State Railway, are about the whole of the work recently placed or anticipated at an early date, and the requirements of the home companies, which it was hoped would have been considerable before this, are still of the hand-to-mouth description.

More attention is being given to the South African markets, where trade is picking up precisely in proportion as the labour difficulty is being solved at the mines. Many of our manufacturers made important arrangements long ago for the expected revival, and this, it is now believed, must soon come. At all events, the reports reaching Sheffield from South Africa are of a more encouraging character, and attention is being given with a view to taking advantage of the expected awakening of business in the Transvaal, Orange River Colony, and other regions.

The steel trade continues very much as previously reported, the demand for crucible qualities for general purposes being scarcely so brisk as could be wished. On the other hand, the business done in fast-cutting qualities of tool steel is satisfactorily maintained; a noteworthy feature of this business is the continuously increasing requirements of the United States. The usual result of a brisk market is already evident in the keenness of competition, all the leading firms having now entered into the manufacture, and thus pressing upon those establishments who were the first to take it up.

In the general lighter trades of the city there is no change to be reported, but the season trade in silver, electro, and cutlery has been fairly good, and the principal work is now well in hand. Although the London merchants have ordered more freely than was at one time expected, the call from the principal provincial centres has not been equal to what was looked for. The exceptionally fine summer had a good effect upon seaside and other health resorts, and rather more business has been done in this quarter than for some previous years.

NORTH OF ENGLAND.

(From our own Correspondent.)

It afforded the utmost satisfaction to everybody connected with trade in this district to learn that the wages dispute at the shipyards on the North-East Coast has, after all, been adjusted without the stoppage of work that was threatened. About 30,000 men would have been directly concerned in the strike or lock-out, and this would have seriously affected work in other industries. A stoppage of work at this period of the year would be specially disastrous to the men themselves, and the only people who might be considered the better for it would be the shipowners, for a lessened output at the shipyards would make it rather less difficult for them. There are far too many steamers offering for freight, and the rates, owing to the intense competition, are too low to allow ordinary vessels to be run at a profit. The placing of fewer new vessels on the market would be of benefit to the various shipping firms. On the other hand, both shipbuilders and their men would have been great sufferers through any cessation of operations. Until late on Tuesday evening traders were greatly disquieted by the prospect of a stoppage of operations at the shipyards.

It will be remembered that the notices were to have terminated on Tuesday of last week, but after prolonged negotiations it was decided to extend the notices for another week, so as to give the general body of men time more fully to discuss among themselves, and vote by ballot whether the reduction should be accepted or not. What leaked out about this voting was not assuring, for it seemed as if the men would prove obdurate, and there appeared to be every likelihood of the worst happening, for the employers were determined to adhere to their claim of 5 per cent. reduction on piece work, and 1s. per week reduction in time wages, reductions which, it was generally acknowledged, were fully justified by the poor prices that had to be accepted in order to secure contracts for new vessels. The negotiations on Tuesday did not bear out the pessimistic anticipations, for they resulted in all the men except the shipwrights agreeing to the reduction, but the masters went so far by way of a compromise, that instead of its taking effect at once it will not be enforced until the first pay day in January. Men receiving 25s. and over will be reduced 1s. per week, those getting from 22s. to 25s. will be reduced 6d., and men earning less than 22s. will suffer no reduction.

With respect to the iron trade, the most prominent subject of attention is still the "gamble" in Cleveland warrants, which has extended rather than otherwise, for it is not now confined to regular operators, who hitherto have been mainly London firms, but the outside public have been drawn in and tempted to speculate. Prices have fluctuated more rapidly than ever, and Cleveland warrants on Wednesday touched a higher figure than has been known since the early part of April, 1903. During November the quotation for warrants rose 3s. 7½d. per ton, making it 6s. 6d. above the minimum price of the year. It is a good many years since the rates advanced so rapidly as in November. On August 5th 43s. per ton was reached, and prices fluctuated between that and 44s. till October 25th; by November 3rd 45s. had been attained; by November 6th, 46s.; on November 25th, 47s.; and on November 28th, 48s. The news from America has done a great deal to stimulate the warrant market. But ordinary consumers are not buying much, as they can see no justification for any such advances as have been made, there is nothing in trade which really warrants them, and they are looking for the collapse in prices which they think is inevitable. A gamble in warrants with so little in general trade to back it up has probably never been reported before, and thus consumers are only buying where necessity compels them to do so. The real condition of trade rather justifies reduced prices.

Seldom have statistics been worse than those of late. For instance, the shipments of pig iron for November were only 68,607 tons, the worst that have been reported in any November since 1893, and they have been worse than those of any month for about three years. They compare with 100,010 tons in November last year, and 105,291 tons in November, 1902, and are far below the November average of the last ten years. At the same time, stocks of Cleveland iron in the public warrant stores have increased to nearly 150,000 tons, 34,000 tons having been added in November alone and 20,139 tons in October. The minimum quantity of the year was 78,013 tons on July 6th, and since then the stock has been nearly doubled. Yet in the face of these most unsatisfactory figures prices of Cleveland pig iron warrants are advancing at an almost unprecedentedly rapid rate. It is stated that some of the makers are themselves putting considerable quantities of their No. 3 pig iron into the public stores.

All pig iron prices have been raised this week, generally about 1s. per ton, and they are closer to warrants than they have been since October. No. 3 Cleveland G.M.B. was sold at 47s. 6d. per ton on Monday, but business was done on Tuesday at 47s. Afterwards 47s. 6d. became the regular price quoted both by producer and merchant, seeing that warrants rose above 48s. No. 1 was put up to 49s. 3d. The lower qualities have been raised, but are still relatively cheaper than No. 3. Thus No. 4 foundry is at 46s.; No. 4 forge, at 44s.; mottled, at 43s.; and white, at 42s.; and it is not easy to find anyone who will do business at less.

The situation in the hematite iron trade is improving substantially and legitimately, speculation having nothing to do with the advance that is taking place, for it is undoubtedly induced by the increased demand from actual consumers. Prices have risen 1s. 6d. per ton during the last week, and are now 3s. 6d. per ton above the recent minimum figures. Mixed numbers are now at 53s. per ton, and No. 4 has been put up to 50s. At the same time Rubio is improving in price, though freights are falling, and this week the regular quotation is 14s. 9d. per ton c.i.f. Tees.

Manufacturers of finished iron and steel give somewhat encouraging reports about business. There is no doubt that some of the firms have been booking orders more freely of late, and now that the wages difficulty in the shipbuilding industry has practically been settled it is probable that business may come forward more freely still. The prices of steel angles and joists have been raised 5s. per ton this week, partly on account of the better demand, and partly because hematite pig iron has become dearer. Steel ship angles are at £5 5s.; steel engineering angles at £5 10s.; and steel joists £5 5s., all less 2½ per cent. Angles are thus 7s. 6d. per ton above the recent lowest. Steel ship plates are firm at £5 12s. 6d., and iron ship plates at £6, both less 2½ per cent. Packing iron is obtainable at £5 less 2½ per cent., that being somewhat cheaper than last week. Steel bars are at £6; and iron bars at £6 2s. 6d., less 2½ per cent. Heavy steel rails are at £4 10s. net.

The return collected by Mr. Waterhouse, on behalf of the Board of Conciliation and Arbitration, for the manufactured iron trade of the North of England shows that during September and October the average price realised for the manufactured iron delivered was £5 19s. 1·03d. per ton, that being 2·66d. less than in the previous two months, and, in that case, wages for December and January at the finished ironworks in the North of England will remain as during the past two months; indeed, since April, 1902, they have only once been altered, viz., in March, 1904, when they were reduced 2½ per cent. Realised prices have this year fallen 4s. 9·72d. per ton, and they are £2 6s. 10d. less than in October, 1900, when the highest price of recent years, £8 5s. 11d., was reached. Lower prices than the present were reported in 1895 and 1886, the rate in the latter year being down to £4 11s. 2d., which was the lowest ever reported. Iron rails in the last two months averaged £5 6s. 2d. per ton, decrease on previous two months 6s. 4d.; iron plates, £5 19s. 4d., increase, 10½d.; bars, £5 18s. 7d., increase 1d.; and angles, £6 2s. 7d., decrease 2s. 8d.

The Cleveland Bridge and Engineering Company, Darlington, have completed the approach spans of the new high-level bridge over the Tyne for the North-Eastern Railway Company, and are now engaged with the central spans. They expect to complete the bridge over the Victoria Falls on the Zambesi River in Central Africa by next June, and have on hand a large viaduct for New Zealand.

The death is announced of Mr. A. D. Rickaby, of the Bloomfield Engine Works, Sunderland, which he established, and in which he was very successful. He was born at Coniscliffe, near Darlington, 86 years ago.

The coal trade is quiet but steady. Best steam coal is not offered, or, indeed, sold, under 9s. per ton f.o.b.; in fact, colliery proprietors reduce output rather than take any lower price, for that cannot leave them any profit. Small steams are scarce, and the price has improved to 4s. per ton. Gas coals are firm at 8s. 1½d., and seconds at 7s. 9d., and pretty nearly the full output of the district is raised. Coke prices are going up, partly in sympathy with the increase in the quotations for pig iron, and medium is realising 14s. 4½d. per ton delivered at the furnaces here, while foundry coke is at 15s. 9d. per ton f.o.b. Coke manufacturers are requiring 6d. per ton more for next half-year's contracts than was taken for the second half of this year.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

The pig iron market has shown a good deal of strength this week, and prices of warrants reached a higher figure than before. Of course, the upward movement is attended with re-action, but so far, on the whole, material progress has been made in prices. It is now pretty generally recognised that a large proportion of the buying of pig iron within the last few weeks has taken place in anticipation of orders for material that may be given out later. The movement is thus of a speculative nature.

Local consumers of raw iron are reported to be purchasing sparingly, and the sudden advance in prices has caused them no little inconvenience, as it has been found impossible to obtain a corresponding increase in the prices of manufactured goods.

Business has been done in Cleveland warrants from 47s. 3d. to 47s. 10d. cash, 48s. 2d. for delivery in twenty-four days, and 47s. 7½d. to 48s. 3d. one month. Scotch warrants are quoted 53s. 3d., and Cumberland hematite 55s. 3d. per ton.

An additional furnace has been placed on ordinary iron, and there are now 85 furnaces blowing in Scotland, compared with 87 at this time last year.

A further advance has been made in the prices of Scotch makers' iron, varying from 6d. to 1s. 6d. per ton. G.M.B. No. 1 is quoted at Glasgow, 54s.; No. 3, 50s. 6d.; Carnbroe, No. 1, 55s.; No. 3, 51s. 6d.; Clyde, No. 1, 57s. 6d.; No. 3, 52s. 6d.; Gartsherrie, No. 1, 58s.; No. 3, 53s.; Langloan, No. 1, 64s.; No. 3, 54s.; Coltness, No. 1, 63s. 6d.; No. 3, 53s. 6d.; Glengarnock, at Ardrossan, No. 1, 57s. 6d.; No. 3, 52s.; Eglinton, at Ardrossan or Troon, No. 1, 53s.; No. 3, 50s. 6d.; Dalmellington, at Ayr, No. 1, 53s. 6d.; No. 3, 50s. 6d.; Shotts, at Leith, No. 1, 58s.; No. 3, 52s.; Carron, at Grangemouth, No. 1, 57s. 6d.; No. 3, 51s. per ton.

The prices of Scotch makers' hematite pig iron are also moving upwards, and have advanced 6d. since last week. Merchants now quote 57s. per ton for delivery at the West of Scotland steel works.

The shipments of pig iron from Scottish ports in the past week amounted to 5476 tons, compared with 5490 in the corresponding week of last year. There was despatched to South America 335 tons; India, 443; Australia, 305; France, 100; Italy, 130; Germany, 83; Holland, 160; Belgium, 30; Spain and Portugal, 30; China and Japan, 50; other countries, 474; the coastwise shipments being 3336 tons, compared with 3953 in the corresponding week of last year.

The arrivals of Middlesbrough pigs at Grangemouth were 9732 tons, compared with 6555 in the corresponding week, showing an

increase of 3177 tons. There is, however, a total decrease in these imports during the past eleven months of 95,059 tons.

There is not much of importance to note in connection with the finished iron and steel trades. The makers of finished iron report, in some cases, rather better inquiry, but steel makers have difficulty in keeping the works going full time. The engineering trades, as a whole, are quiet, but improvements are noted here and there, and these, it is hoped, may ere long become more general.

There were launched from the Clyde shipbuilding yards in November seventeen vessels, of 25,118 tons, and these compare with 26,471 tons in November, 1903. The aggregate output of the eleven months is 357,944 tons, against 371,810 in the corresponding period of last year, the figures for 1902 being 451,936 and 461,194 tons for 1901. It should be stated that the last-mentioned figure is the highest in the history of the trade. New work received during the month is estimated at about 67,000 tons, and this must be recognised as a distinct improvement. A number of fresh contracts have been received in the course of the last few days.

It is not surprising that the total shipments of coal from the Scottish ports in the past week should show a small decrease. There has been a good deal of detention of traffic on the railways, and frost and fog have interfered to some extent with inland communication. The total shipments were 219,204 tons, against 228,481 tons in the preceding week, and 222,851 tons in the corresponding week of last year. The demand for house coal for home use has been very brisk, and as a consequence many of the coalmasters have intimated an advance of 1s. per ton on prices.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE coal world of Cardiff has been disturbed—I was going to write excited—by outside comments respecting the coal that has been acquired by the belligerents, and by the protest of Japan that the Russian Baltic fleet could not have sailed but for Cardiff coal. From what I learn, both parties are as wary as the other in buying, and although salesmen may have suspicions, there could be no certainty as to the final destination. A good deal of coal has been shipped in German bottoms, which probably has been finally bought by one or the other. As regards the possibility of a Japanese or Russian man-of-war moving without Cardiff coal, that is an admission of Welsh superiority which Northern and Scotch coalowners would question.

The latest statement on 'Change is that half a dozen steamers have been fixed to load this month for Japanese waters.

The leading coalowners of Cardiff have been notified by the Admiralty to submit tenders, stating quantities that could be supplied, and the prices for 1905. It is expected that about one and a-quarter million tons will be needed. The rough total load for this year has been about 1,200,000 tons.

Some degree of slackness characterised the steam coal trade last week at all ports. Newport was only moderately busy, and Swansea only despatched 40,000 tons, half going to France.

On 'Change, midweek, Cardiff, there was not much improvement, owners stating that forward coals were not in brisk demand; best steam only keeps to its late figures, and, in other coals, buyers are able to get small concessions. This does not apply to house coal, which is firm, both in requirement and price. Sales have been effected at 17s. for best, and London by putting up prices 1s. per ton is clearly indicating the trend of business. There will be no failure in quantity as regards Wales; but coal prophets predict a hard winter and dear coal.

Closing coal prices this week were as follows:—

Best steam, 13s. 3d. to 13s. 6d.; best seconds, 12s. 9d. to 13s.; ordinary seconds, 11s. 6d. to 12s.; drys, 11s. 9d. to 12s. 3d.; best smalls, 7s. to 7s. 3d.; best ordinaries, 6s. 3d. to 6s. 6d.; seconds, 5s. 9d. to 6d.; inferiors, including drys, from 5s. 6d. Monmouthshire semi-bituminous: Best large, 11s. 9d.; best ordinaries, 11s. 3d. to 11s. 6d.; seconds, 10s. 6d. to 10s. 9d. House coal: Best, 16s. 6d. to 17s.; best ordinaries, 13s. 6d. to 14s. 6d.; seconds, and other sorts, from 10s. 6d. to 13s. No. 3 Rhondda, 13s. 3d. to 13s. 6d.; brush, 11s. 6d. to 11s. 9d.; small, 8s. 9d. to 9s. No. 2 Rhondda, 9s. 9d. to 10s.; through, 8s. 3d. to 8s. 6d.; small, 6s. 6d. to 6s. 9d. Patent fuel, 12s. 6d. to 13s. Coke: 15s. to 16s. for furnace qualities; foundry, 16s. 6d. to 20s.; market slow. Pitwood, 18s. 6d. to 18s. 9d. firm.

Newport quotations this week were up to 19s. 3d.

Outward chartering getting more brisk at close of week. Rates for upper and lower Mediterranean ports very steady. Bay and coasting rather dull. Coalowners report that steam for loading are good for December.

In the Swansea market a steady tone was noted this week, with no change in prices of any account. Steam is selling from 12s. 6d. to 13s.; No. 3 Rhondda, 13s. to 13s. 6d.; patent fuel, slack, 11s. 6d. to 11s. 9d. Anthracite coal is in steady demand—quite equal, stated an owner, to the average for this time of the year; best malting selling for 20s. to 21s.; second malting, 17s.; big vein, 11s. 6d. to 12s.; red vein, 9s. 9d. to 10s.; machine-made cobbles, 17s. to 17s. 6d.; nuts, 18s. 6d. to 19s.; peas, 11s. to 12s.; rubbly culm, 4s. 6d. to 5s.; duff, 4s. Referring to Cardiff coal trade, an authority on 'Change calls attention to the prices of second Admiralty steam, remarking that, relatively, they are in a better position than the first class.

In respect of best steam coal, it is known that large sales have been concluded over the year at 13s. and 13s. 3d., that one large seller has secured two contracts over the year at 13s. 9d., and is now obtaining 13s. 6d. for December. "As," states the authority, "the firm obtained 14s. for the great bulk of its contract coal, the fall of 3d. may be taken to represent the difference between the ruling figures for 1904 and the estimate ruling for 1905." All this is, possibly, speculation, which Far East movements and European action would discount.

The tin-plate trade continues in a most flourishing condition. This has now lasted some time, and, if occasionally there has been a poor week of shipments, it has been due to prevailing fog or stormy weather hindering tonnage from coming in. Every week of late there has been full work at the mills. Last week 70,000 boxes were turned out, but as 142,271 boxes were despatched there was an inroad on stocks, which are now down to about 134,000 boxes. Far East took 6000 tons in the s.s. Wray Castle; the s.s. Tenedos for Antrim and Odessa took 4000 tons.

Activity in tin-plate is also telling favourably upon other industries. There is a fair demand for home-made steel bars, and a large make was turned out last week, quite in unison with the output of plates at the mills. In spelter there is considerable activity. The Middle Bank are adding two furnaces, which will soon be ready.

Copper works are fully employed, and regularity denotes operations at the Mond metal factory. Mannesmann tube works fairly occupied, and so also Gloucester wagon works.

A marked extension is to be carried out at Lysaghts, Newport, Mon., where a new mill is to be added on the American principle. This will bring the total of mills up to thirty; four Welsh mills, twenty-five English, and one American. This will make the works the largest of the kind in the country.

Blaenavon imported one cargo of ore from Spain this week totalling 3000 tons, and Ebbw Vale one of 3100.

A consignment of billets from America, *vid* Liverpool, was received this week, and pig iron from Millom and Ardrossan at Swansea; and Newport received a quantity; pig iron from Whitehaven, and tin bars from Liverpool. Port talbot despatched a cargo of tin-plates and black plates to France. Dowlais continues its make of steel rail. In other matters the make at these works was only moderate. Furnace yields, Bessemer and Siemens, were quite up to average. Importation of Spanish ore large, and in the engineering departments full time was worked.

On 'Change, Swansea, there has been good attendance, and marked animation of late. Large buyers from London, the Midlands, and other quarters, have been present, and the outlook of trade is promising. Midweek, it was stated that the improvement recorded all round was well maintained, and a good deal of business extended even into 1905.

In pig iron the advance since last week is:—Scotch warrants 9d., Middlesbrough 1s. 3d., hematite 1s. 6d. Tin bars advanced, and in block tin quotations show an advance, touching £4. Closing prices are as follows:—Pig iron: Glasgow warrants, 53s. 6d.; Middlesbrough No. 3, 47s. 3d.; hematite warrants, Cumberland, 55s. 6d.; Welsh merchant bars, £6 2s. 6d. to £6 5s.; Bessemer tin bars, £4 4s. to £4 5s.; Siemens best, £4 5s. to £4 7s. 6d. Steel rails, heavy, £4 5s. to £4 10s.; light, £5 5s. to £5 10s. Sheet iron, £8 to £8 10s.; steel sheets, £8 to £8 2s. 6d. Tin-plate: Bessemer steel coke, 12s. 6d to 12s. 9d.; Siemens, 12s. 9d. to 12s. 10½d. Ternes, 22s. 6d. to 24s. 6d.; best charcoal, 14s. to 14s. 6d. Big sheets, for galvanising, £8 17s. 6d. to £9. Finished black plate, £8 15s. to £8 17s. 6d. Block tin, £136 7s. 6d.; spelter, £25 2s. 6d.; lead, £13 2s. 6d.; copper, £66 10s. Iron ore: rubio, 13s. 6d. ex ship.

The pioneer motor experiments of the Taff Vale Railway, which have been attended with considerable success, were extended last week to the Aberdare Valley, the carriages carrying seventy persons.

It was currently rumoured in the Swansea district this week that—as stated in a leading Canadian paper—negotiations are being entered upon with a Welsh company to erect a tin-plate plant in Canada. This is being much discussed, but I must wait to see if there is any foundation for the statement. The place selected is given as Torrisbury.

A new steamer, of the Shaw, Savill and Co. Line, 7000 tons burden, is expected to bunker at Barry.

An accident occurred last week at the Western Colliery of the Ocean Company which might have been very serious. In letting down the cage with eight men it was arrested after descending 30 yards by the fangs; fortunately the rope held, and the most serious mishap was a broken leg.

In the Newport district it is currently rumoured that authorities will oppose the Barry proposal to tap the Sirhowy Valley.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, November 14th.

FROM advance sheets of the annual report of the American Iron and Steel Association the following figures as to iron and steel production, iron ore, and coke, with exports of coal, appear:—

Subjects.—Calendar years.	1902.	1903.
Production of iron ore, gross tons	35,554,135	35,019,308
Imports of iron ore, gross tons	1,165,470	980,440
Production of bituminous coal, gross tons	232,336,468	252,454,775
Production of Pennsylvania anthracite, gross tons	36,940,710	66,613,454
Production of all kinds of coal, gross tons	269,277,178	340,068,229
Shipments of Pennsylvania anthracite, gross tons	31,200,890	59,362,831
Imports of coal, gross tons	2,551,381	3,446,402
Exports of coal, gross tons	6,126,946	8,312,098
Production of coke, net tons	25,401,730	25,262,360
Production of pig iron, gross tons	17,821,307	18,009,252
Production of spiegeleisen and ferro-manganese, included in pig iron, gross tons	212,981	192,661
Production of Bessemer steel, gross tons	9,138,363	8,592,829
Production of open-hearth steel, gross tons	5,687,729	5,829,911
Production of crucible steel, gross tons	112,772	102,434
Production of blister and patented steel, gross tons	8,386	9,804
Production of all kinds of steel, gross tons	14,947,250	14,534,978
Production of open-hearth steel castings, gross tons	367,879	400,348
Production of all kinds of steel castings, gross tons	390,935	430,348
Production of Bessemer steel rails, gross tons	2,935,392	2,946,756
Production of open-hearth steel rails, gross tons	6,029	45,054
Production of iron rails, gross tons	6,512	667
Production of all kinds of rails, gross tons	2,947,933	2,992,477
Production of structural shapes, gross tons	1,300,326	1,995,813
Production of iron and steel wire rods, gross tons	1,574,293	1,503,455
Production of plate and sheet iron and steel, except nail plate, gross tons	2,665,409	2,599,665
Production of iron and steel cut nails and cut spikes, kegs of 100 lb.	1,633,762	1,435,893
Production of iron and steel wire nails, kegs of 100 lb.	10,982,246	9,631,661
Production of bar, bolt, hoop, skelp, rolled axles, rolled armour plate, &c., gross tons	5,383,219	4,952,185
Production of all rolled iron and steel, including cut nails and excluding rails, gross tons	10,996,183	10,215,220
Production of all rolled iron and steel, including both cut nails and rails, gross tons	13,944,116	13,207,697
Production of tin-plates and terne plates, gross tons	360,000	480,000
Production of ore, pig, and scrap blooms for sale, gross tons	12,002	9,940
Value of imports of iron and steel, dols.	41,468,826	41,255,864
Value of exports of iron and steel, dols.	97,892,086	99,035,865
Miles of new railroad built (revised figures)	5,063	4,715
Immigrants in the year ended Dec. 31st	739,289	987,371

Prices of all kinds of crude and finished iron and steel have suddenly rebounded, and quotations at this port to-day are as follows:—No. L X foundry northern, 16·75 dols.; No. 2 X northern, 16·25 dols.; No. 2 plain, 15·75 dols.; gray forge, 14·75 dols.; basic, 15·75 dols.; No. 1 Virginia foundry, 16·15 dols.; southern gray forge, 14·25 dols. Prices for pig iron have advanced in all eastern markets from one to two dollars per ton over prices quoted by the Association. The Frick Company have sold up and retired from the market which sent coke sky-rocketing, with furnace and foundrymen everywhere on the warpath. This sudden transition from dulness to speculative activity exemplifies the course of the American iron market.

The requirements for copper in the domestic markets are quite active this week. The high prices have rather stimulated than checked demand. A good many consumers are afraid of the speculative tendency, and a good deal of iron is being held on speculative account at this moment. It is expected that electrolitic will move up to 15 cents. Very little is doing in the minor metals, but lead is very strong; spot is 4½ cents; St. Louis, 4·27½ cents; spelter, 5½ cents for spot. Very little is being done in tin at present.

The sudden improvement in the iron market has stimulated a demand for lake ore, and large dealings are in progress, which by the end of the year will, perhaps, almost equalise the shipments between this year and last.

In financial circles a speculative movement has set in under favourable crop reports. The November report of the Government for maize is 2,453,000,000 bushels. The wheat crop, while less than usual, will probably bring more money.

NEW YORK, November 21st.

Developments in the steel industry during the past few days have been of a rather surprising nature, and new business is coming to the surface, which owners of furnaces and mills are glad to accept at higher prices for winter and spring delivery. This activity for deliveries three to six months hence is quite a surprise to the industry, and there are many who believe that the policy of customers is altogether unwarranted. Quite a number of the larger buyers recognise that if this present advancing tendency should continue, it will introduce a feature calling for extreme caution. The point is simply this, that conditions do not warrant the advances now being made, but those who are securing large contracts feel that the safer policy is to buy sufficient raw material to enable them to execute these contracts. A few months ago only about half the producing capacity was active, and even now a considerable percentage is still idle. Large consumers ask the question why, in the face of such conditions, must they be called upon to pay more money for iron and steel products. Manufacturers answer that they are not responsible for the advanced quotations in ore and pig iron. Had pig iron producers during the period of dulness from which we are now emerging continued to produce iron and stock it up, no such advances as are now announced would be possible. On the first sign of restricted demand furnaces bank up or blow out, stocks disappear and the market becomes bare. Circumstances then develop an active demand, orders rush in for equipment and material, and the manufacturers discover that they have no material on hand and rush into the market and buy. This short-sighted policy has been characteristic of the American iron and steel market for years, and it is not probable that it will ever be changed.

There is difference of opinion as to the probable duration of the present activity. Men like Charles M. Schwab are confident that the demand for furnace and mill products will increase and continue throughout 1905. This would be a safe opinion to entertain if we could rely upon a policy of expansion in transportation facilities on the part of the railroads. The railroad companies, ever since the liquidation of values which struck railroad securities two years ago, have been pursuing a cautious policy largely under the dictation of the banking influences which stand behind a good many American railway systems. As a consequence, rolling stock and motive power declined, and a great deal of railway construction was temporarily suspended. If the former policy is restored and railroads should again enter on the policy of adding to equipment and building projected lines, there is no reason why the views of Mr. Schwab and others should not be realised.

Inquiries within the past week from railroad companies indicate that a good deal of material will be bought. Producing capacity both of furnaces and mills is being increased. There are good reports from engineering plants engaged in the construction of heavy machinery.

The activity in copper continues, and the high prices prevailing are stimulating production in all the leading copper-mining centres.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market is quieter, as owing to the fogs in the Channel tonnage is rather scarce. House coal is in fair demand, prices unaltered. The quantity of coal shipped for the week ending November 26th was 82,557 tons—foreign, 64,761 tons; coastwise, 17,796 tons. Imports for the week ending November 29th—Iron ore, 9980 tons; bars, &c., 2731 tons; pig iron, 2810 tons; scrap, 40 tons; pitwood, 3577 loads.

Coal—Best steam, 11s. 6d. to 11s. 9d.; seconds, 10s. 6d. to 10s. 9d.; house coal, best, 15s.; dock screenings, 6s.; colliery small, 5s. 3d. to 5s. 6d.; smiths' coal, 9s. Pig iron—Middlesbrough No. 3, 47s. 11d. to 48s. 1d.; Middlesbrough hematite, 55s. 4½d. to 56s. Iron ore—Rubio, 13s. 6d.; Tafna, 14s. 6d. Steel—Rails, heavy sections, £4 5s. to £4 10s.; light ditto, £5 5s. to £5 10s.; Bessemer steel tin-plate bars, £4 2s. 6d. to £4 5s.; Siemens steel tin-plate bars, £4 5s. to £4 7s. 6d., all delivered in the district, cash. Tin-plates—Bessemer steel, coke, 12s. 6d. to 12s. 9d.; Siemens, coke finish, 12s. 9d. to 12s. 10½d. Pitwood—19s., ex ship. London Exchange telegrams—Copper, £66 10s. to £66 12s. 6d.; Straits tin, £136 5s. to £136 10s. Freightsactive and steady.

CATALOGUES.

MATHER AND PLATT, Limited, Manchester.—Catalogue of polyphase induction motors, second edition. The particulars given provide all necessary data of machines ranging from 5 to 500 horse-power.

L. SCHULER, 138, Southwark-street, London.—Schuler's patented hydraulic drawing presses.—A full and lengthy description of this type of press is given in this pamphlet, together with readable illustrations and diagrams.

LANCASHIRE STEAM MOTOR COMPANY, Limited, Leyland.—An excellently got-up catalogue of steam wagons has been issued by this firm. The engravings are well produced on a large scale, and include illustrations of many different applications to which this type of vehicle have been applied.

BRYAN DONKIN AND CLENCH, Limited, Lincoln Works, Chesterfield.—This catalogue is devoted to a description of the Mahla-Donkin bomb calorimeter for testing the calorific value of coals, oils, &c. We are informed that as a result of careful experiment these calorimeters give results within 0·3 per cent. of the true calorific value of the fuel under test.

BRUSH ELECTRICAL ENGINEERING COMPANY, Limited, 106-112 Belvedere-road, London, and Loughborough. Bulletin No. 7.—This publication is devoted to direct-current motors. These are of the slotted drum armature iron-clad type, with four poles, and may be shunt, compound, or series wound. The book is produced in a highly creditable manner. Bulletin No. 9, recently issued, deals with induction motors. These are made for two and three-phase supplies at 40 and 50 cycles, and range in output from 3 to 60 brake horse-power.

LEEDS ASSOCIATION OF ENGINEERS.—At a meeting of the Leeds Association of Engineers held on November 24th, Mr. A. H. Hopkinson read a paper on "Steam Stop Valves and Gauges." Under modern conditions of steam, he said, the ordinary screw-down or wedge type of valve was difficult to make fluid tight and was often dangerous. This had been borne out by the Board of Trade reports. Mr. Hopkinson pointed out the common defects, and described a valve in which he maintained these were practically eliminated. In addition to proper mechanism, he said, the materials should be suited to the different parts, the workmanship accurate, and each part separately tested both by water and steam. Valves had been made which worked satisfactorily under a pressure of 350 lb. per square inch, and with 300 deg. of superheat. In the course of the discussion, Mr. Robinson said that he had experienced some unfortunate accidents with steam valves. There was a continued re-adjustment necessary between increased steam pressures and more efficient valves. He expected to see pressure of 1000 lb. to the square inch. The president, Mr. G. R. Goldsack, occupied the chair.

CONTRACTS.—The American Car and Foundry Company, which recently secured the contract from the London Underground Railway to build a large number of steel passenger cars, similar to those in use on the New York Subway, has decided to build them in this country, and has placed an order with John Macdonald and Son, Glasgow, for the whole of the pneumatic equipment required for the purpose, including four Ingersoll-Sergeant air compressors and 125 Haeseler pneumatic hammers and drills, and all accessories.—Messrs. Mackay Brothers, of Alloa, have just received an order from the Shipping Agency, Limited, London, for two steamers, each about 140ft. long.—Joseph Wright and Co., Tipton, have received orders for Berryman patent feed-water heaters from the Bradford Dyers' Association for the Bridge-street Dyeing Company, Limited, and for the Standish Company, Limited, of Standish Works.—The Hart Accumulator Company's tender for the supply of a storage battery of 115 1050 ampère-hour standard lighting type cells for Napsbury Asylum has been accepted by the Middlesex County Council.

NOTES FROM GERMANY.

(From our own Correspondent.)

THOUGH there has been a little more life in some departments of the iron industry over here, the reports generally given are not very encouraging, as the increasing demand that could be noticed for several articles is not sufficient to cause any marked increase in activity.

Crude iron sells fairly well in Rheinland-Westphalia. Scrap iron is in moderate request, and the strong effort that is made to maintain prices cannot be reported to have been generally successful, quotations showing a tendency downwards. In the semi-finished steel department no much briskness can be noticed, the demand on home and foreign account being rather limited; the contest between the producers, or rather the Steel Convention, and consumers continues, to the disadvantage of the general iron business. Girders are dull, and in the bar trade a moderate inquiry is reported. The mills outside the syndicate try to secure offers in steel bars at any price almost. Hoops and plates are languid, and the business in gas pipes, though slightly better than previously, is still unsatisfactory, especially with regard to prices. Wire is in moderately good request.

On the pig iron market in Silesia a fair activity can be noticed. The majority of the blast furnace works have already covered their demand in ore for 1905. A slight scarcity in iron ore could be felt in consequence of the revival in the pig iron department, and the raised prices of next year have been willingly paid.

Last week 400,000 t. iron ore have been sold in Upper Silesia. Girders and plates as well as sheets are generally in fair demand, though there is much room for improvement. The business done on foreign account was more healthy than a few weeks ago.

According to official reports given by the Union of German Iron and Steel Masters, the production of pig iron in Germany, including Luxemburg, was for October of present year 868,528 t., against 833,578 t. in the month before, and against 869,463 t. in October, 1903; 173,574 t. were foundry pig, 26,817 t. Bessemer, 547,800 t. basic, 56,072 t. spiegeleisen, and 64,170 t. forge pig. Compared with September, output rose 34,945 t., or 4·19 per cent., and was the highest production per month since November, 1903; in the same month last year—October, 1903—output in pig iron was, however, 940 t. higher still. A slight decrease in production could be noticed in the Saar district, 132 t., and South Germany, 180 t.; in all other districts output shows an increase, which was specially strong in Rheinland-Westphalia, + 11,816 t.; Luxemburg-Lorraine, + 11,107 t.; the Siegerland and Hessen-Nassau, + 17·9 per cent. Regarding the different sorts of iron, a strong decrease can be noticed in the production of forge pig, 6507 t. less being produced than in October last year.

For house coal an improvement in demand could be noticed on the Rhenish-Westphalian market, but engine fuel remains in comparatively quiet request. Large lots of the cheaper sorts of coal are being exported to France.

A strong improvement in the business in house coal was likewise perceptible in Silesia; also engine coal has been in much better call, and the present low quotations are likely to meet with an advance before long. Coke, too, has been in much better request than formerly.

The reductions in tariffs on the Austrian Kaiser-Ferdinand-Nord-Bahn will be detrimental to the German export in coal, especially that of the Upper Silesian pits, which used to export one-third of their deliveries to Austria. The new tariff favours shipments from the Ostrau-Karwics district to such an extent that from Ostrau to Tarnow the freight will be 7 pf. per cwt. less than formerly, while for German coal the full freight has to be paid.

The position of the Austro-Hungarian iron market has been pretty favourable during the week, and more orders of fair weight could be secured. The new Alpine railways have ordered rails, fish-plates, and plates, worth 202,000 crowns; also a contract for switches and crossings, worth 738,000 crowns, has been given out, and further orders are expected to be placed in the course of the next month for delivery in spring.

The cold weather that has set in everywhere now, causing a rise in the demand for coal and coke, has also had a favourable influence on the Austro-Hungarian coal trade. Deliveries increase, and prices are very stiff; likewise brown coal has considerably improved, and the Elbe traffic has again increased. From January 1st to end of October of present year Elbe shipments in brown coal were 11,680,000 q., against 20,550,000 q. in the same period the year before, which is equal to a decrease of 9,000,000 q.

In the French iron industry activity last week has been less regular than before, and the works in the Centre and North complain of the decrease in orders and employment. A report of the *Frankfort Gazette* from Brussels says that the representatives of the French works have given their consent to the forming of an International Girder Convention.

The French coal trade is quiet, a normal inquiry coming in. The coalowners of the North intend to join in a sort of syndicate that would take in hand the selling of coal, more especially to the blast furnace works. A fairly steady business, with an absence of animation in many trades, however, can be reported from the Belgian iron and steel market. Rails and girders meet with tolerably good demand.

A normal and pretty healthy business is done in both engine and house coal in Belgium. Coalowners, as well as consumers, report themselves fairly well content with the development of the coal industry.

TRADE AND BUSINESS ANNOUNCEMENTS.

MR. H. F. GOLDING, chief draughtsman, Taff Vale Railway Company, Cardiff, has been appointed locomotive superintendent at Penarth with that company.

MR. THOMAS POWELL, formerly assistant secretary, has been appointed a director and secretary of the Pullman Company, Limited, in succession to the late Mr. John S. Marks.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

16th November, 1904.

24,810. SEALING of MILK CHURNS, A. E. Field, Southsea, Hants.
24,811. EXTINGUISHER for SPIRIT LAMPS, C. Wilton, London.
24,812. COMBINED COAL-SAVER TRIVET, W. Bagnall, Birmingham.
24,813. HATPINS, C. F. Couzens and A. Brown, Cardiff.
24,814. GAITERS, T. W. Hill, London.
24,815. SPRING WHEELS, H. F. Woodgate, Brecon, South Wales.
24,816. PUZZLE, E. J. Frewen, London.
24,817. REFUSE WAGONS, R. Hitchcock, Taunton, Somerset.
24,818. UNPUNCTURABLE TIRES, E. H. Crabb and H. Marriott, Parkstone, Dorset.
24,819. MAKING YARD TRAP, F. R. Lovett, Portsmouth.
24,820. FURNACES for MELTING METAL, G. Craig, Glasgow.
24,821. FASTENING for BROOM HANDLES, H. J. Shinkfield, London.
24,822. SLIDING SEATS for DOG CARTS, J. A. Thomson, Edinburgh.
24,823. SMELTING IRON, W. H. Webb, W. G. Brettell, and A. J. Adamson, Liverpool.
24,824. VALVES, T. K. Crossley and G. Jones, jun., Liverpool.
24,825. DUSTLESS CINDER SIFTER, S. W. Bullas, S. W. Bullas, jun, and F. J. and P. H. Bullas, Cradley Heath.
24,826. CONSTRUCTION of GAS FURNACES, H. A. Mavor, Glasgow.
24,827. DRIVING MECHANISM of LOOMS for WEAVING, A. Smith, F. Leeming, and C. Hudson, Keighley, Yorks.
24,828. RAISING ELECTRIC ARC LAMPS, W. F. Mason, Manchester.
24,829. PACKINGS, G. F. Miller and J. Kronier, Cologne, Germany.
24,830. WINDING YARN, T. Pickles, Manchester.
24,831. ACTUATING TRAMWAY POINTS, E. Rothwell, Manchester.
24,832. ROTARY METERS, T. Thorp, Manchester.
24,833. BEARINGS of WHEELS, A. W. Harrison, Liverpool.
24,834. PIPE COUPLINGS, J. S. Price and E. L. G. Muggeridge, Southwick, Sussex.
24,835. FIXING REMOVABLE COVERS for TYPEWRITERS, R. Stroud and Son, Limited, and S. W. Turner, Wolverhampton.
24,836. PENDENT and GLOVE MIRRORS, E. H. Durban, Birmingham.
24,837. INTERNAL COMBUSTION ENGINES, C. Barclay, Liverpool.
24,838. REGULATING TEMPERATURE in STEAM GENERATORS, R. P. Roy, London.
24,839. DEEP SEA SOUNDING MACHINES, J. C. Dobbie, London.
24,840. PROCESS of TREATING SOOT, A. Macknight, London.
24,841. FRICTION CLUTCHES, E. T. Cleathero, Altrincham, Cheshire.
24,842. HEADS of GOLF PUTTERS, F. Hallworth, Manchester.
24,843. FIRE LIGHTERS, R. Fuhrmann, Cologne, Germany.
24,844. TANTALUS SPIRIT STANDS, G. Villiers, London.
24,845. PREVENTING ACCIDENTS in HOISTS, R. E. Oddy, Leeds.
24,846. DOLLS' FACES, F. E. Eaton, Co. Dublin, Ireland.
24,847. CHANGE SPEED GEAR, G. Gilbert and E. Mushing, Coventry.
24,848. OIL LAMPS, H. L. Todd and W. Wright, London.
24,849. STANDS for EXHIBITING MODELS, A. Shacklock, London.
24,850. DETECTING ALTERNATING ELECTRIC CURRENTS, J. A. Fleming, London.
24,851. NAVIGABLE VESSELS, J. Casey, London.
24,852. METALLIC PASSENGER CARS, G. I. King, London.
24,853. REDUCING FRICTIONAL LOSS in TURBINES, C. Bauer.—(*F. Herles and J. Norik, Austria.*)
24,854. TILES, H. Dickinson and F. R. Marshal, London.
24,855. BICYCLE SUPPORT, G. W. Sutton, Stevenage, Herts.
24,856. CARD, H. St. J. Bare, London.
24,857. ELECTRICITY METERS, C. A. A. Capito, London.
24,858. MUSICAL HORN for MOTOR CARS, G. Davenport, London.
24,859. MILKING ANIMALS, R. L. Power, London.
24,860. NON-REFILLABLE BOTTLES, H. M. Wilkinson.—(*A. Ouillé, France.*)
24,861. MACHINES for INSERTING FASTENINGS, A. J. Boult.—(*United Shoe Machinery Company, United States.*)
24,862. STEAM WHISTLES, J. Miller, London.
24,863. MARKING GOODS, D. Henderson and J. E. Harding, London.
24,864. PNEUMATIC TIRES, T. Sloper, London.
24,865. ENVELOPES for PNEUMATIC TIRES, T. Sloper, London.
24,866. SUPPLYING BOILERS with WATER, P. Diamond, London.
24,867. SUPPORTS for INCANDESCENT MANTLES, I. M. Hutch and H. F. Joel, sen., Ilford, Essex.
24,868. INTERNAL COMBUSTION ENGINES, J. D. Roots, London.
24,869. PRODUCING ANTHRAQUINONE DERIVATIVES, H. E. Newton.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
24,870. CONDENSING LIQUIDS, H. W. Southworth, London.
24,871. MACHINE for DRILLING SLATE, J. D. Pearson, London.
24,872. GAS METERS, T. L. Cuttell and The Anti-Vibration Incandescent Lighting Company, Limited, London.
24,873. REGULATING ARC LAMPS, J. Brockie, London.
24,874. ALTERNATING CURRENT GENERATORS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,875. CONTROLLING ELECTRIC MOTORS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,876. SPEED-CHANGING DEVICE, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,877. WINDING FRAMES, P. Taylor, London.
24,878. CRYSTALLISING SWEETMEATS, S. J. Mackenzie and Co., Limited, and O. F. Maclagan, London.
24,879. TEMPORARY BINDERS, F. Soennecken, London.
24,880. SOUND-TRANSMITTING TRUMPET, H. Mikorey, London.
24,881. FEEDING BOTTLES, W. R. Dodd, London.
24,882. SIGHTING DEVICE for FIRE-ARMS, H. J. Haddan.—(*M. Haeussler, Germany.*)
24,883. DEVICE for FLUSHING CISTERNS, J. Hayward, London.
24,884. BUCKLES of BELTS, H. Leuthold, London.
24,885. APPARATUS for TREATING PYRITES, W. B. Simons, London.
24,886. RAIL JOINTS, J. W. Cloud, London.
24,887. BALANCES, A. W. Jones, London.
24,888. CHUCKS, H. C. Petitjean, London.
24,889. WATER-LEVEL INDICATORS, J. Dewrance, London.
24,890. STUFFING BOXES, Davy Bros., Limited, and T. E. Holmes, London.
24,891. FOUNTAIN PENS, F. C. Brown, London.
24,892. MANUFACTURE of ARTIFICIAL STONE, L. E. Ford, London.
24,893. VACUUM BRAKE APPARATUS, A. Lonz, London.
24,894. WHEELS for ROAD VEHICLES, G. S. Ogilvie, London.
24,895. VELOCIPEDES, F. Mascias, London.
24,896. WATER-TUBE BOILERS, J., D. C., and G. Finlayson, London.
24,897. ATTACHING HANDLES to SPINDLES, J. Pollock, London.
24,898. SPRING RUNNING GEAR for VEHICLES, J. R. Hill, London.
24,899. GATES, J. F. McNeill, London.
24,900. ELECTRIC BRAKES, A. L. Davis, London.
24,901. CYCLE RIMS, C. H. Apsey and G. B. Duff, London.
24,902. STRIKING MECHANISM for CLOCKS, W. Willmann, London.
24,903. APPARATUS for WASHING GASES, G. M. Capell, London.
24,904. METALLIC WALL COVERINGS, S. O. Cowper-Coles, London.
24,905. TABULATING MECHANISM for TYPEWRITING MACHINES, The Jarvis Typewriter and Tabulator Company and H. Jarvis, London.
24,906. TREATMENT of IMPURE AIR, J. L. Garle, London.
24,907. BORING TOOLS, T. Burns, London.
24,908. FOLDING MAIL CARTS, E. Baumann, London.
24,909. JOINTS of PIPES and CONDUITS, R. Lawton, London.
24,910. DEVELOPING PHOTOGRAPHIC PLATES, H. and H. Tirmann, London.
24,911. WRAPPER for ROLLS of MONEY, A. J. Boult.—(*E. F. Fietz, Germany.*)
24,912. MEANS for OPERATING WINDOWS, C. Rosenheim and G. Mombel, London.
24,913. DETERGENTS, E. W. Lucas, London.
24,914. WHEELS for AUTOMOBILES, E. E. Powers, London.
24,915. INSULATING COILS, J. S. Highfield, London.
24,916. UTILISATION of PLASTER CASTS, E. Latham, Liverpool.
24,917. TRAVERSING LADDER, G. B. H. Austin, Victoria, Australia.

17th November, 1904.

24,918. LEADING-IN WIRES for ELECTRIC LAMPS, A. C. Hyde, London.
24,919. FISHING ROD HOLDERS or RESTS, A. R. Barratt, Birmingham.
24,920. WHEEL RIMS, J. Taylor.—(*Les Fils de Peugeot Frères, France.*)
24,921. BARREL KEY and LOCK ATTACHMENT, J. C. C. Coe, East Grinstead, Sussex.
24,922. ASPHALTED PARQUET FLOOR SLABS, K. Amendt, Cologne, Germany.
24,923. LEVERAGE for GEARED MACHINE, W. E. and W. Howard, Longport, Staffs.
24,924. PIVOT and SLEDGE TRAWL HEAD, G. W. Robinson, Grimsby.
24,925. STEAM GENERATORS, W. H. Northcott, London.
24,926. APPLIANCES for DRESSING HAIR, F. M. Storey, Manchester.
24,927. SWITCHES for ELECTRIC RAILWAYS, A. Marshall, London.
24,928. CALENDARS, A. Simmons, London.
24,929. PEDAL MUDGUARD, J. S. Anderson, Birmingham.
24,930. MAKING HECKLE PINS, E. and T. W. Fleming, Keighley, Yorks.
24,931. WORKING HYDRAULIC MACHINERY, S. E. Alley, Glasgow.
24,932. ADVERTISING MEANS, G. Thompson.—(*A. P. Thompson, Spain.*)
24,933. SECURING HANDLES to SPINDLES, G. Hall, Birmingham.
24,934. TAPPET HOLDER, R. McDowall, Rawtenstall, near Manchester.
24,935. PICKERS of LOOMS for WEAVING, H. Taylor, Halifax.
24,936. DISPLAYING ADVERTISEMENTS, E. R. Barnett, Birmingham.
24,937. ATTACHING RINGS to WINDOW CURTAINS, A. Dix, Liverpool.
24,938. STEAM TRAPS, J. and H. J. Hargreaves, Halifax.
24,939. ADJUSTABLE SWING COT and CHAIR, A. E. Brookes, Blackpool.
24,940. EARTH-CLOSETS, G. Bradley, Hampton Wick, Middlesex.
24,941. VENTING CASKS and BARRELS, A. M. McQuat, Leeds.
24,942. CYCLE STANDS and CARRIERS, G. P. Main, Birmingham.
24,943. DEVICE for FORMING STAVE-CASKS, J. Tropf, Berlin, Germany.
24,944. SCHOOL DESKS, A. Hoch and C. Hannemann, Manchester.
24,945. WINDOW SASHES and FRAMES, W. J. Cowan, London.
24,946. STEAM TURBINES, W. Rummel, Manchester.
24,947. LOOM MOTION, J. Rostron and T. Worman, Manchester.
24,948. CATTLE-HANDLING APPARATUS, I. Goldinger, Manchester.
24,949. NON-SKIDDING TIRE DEVICES, C. H. Wilkinson, Huddersfield.
24,950. SOUND-PRODUCING APPARATUS, H. B. Cutler, Hull.
24,951. MEDICAL APPLIANCE, T. and J. R. Cooke, London.
24,952. SCAFFOLDING, F. Swallow, Hull.
24,953. MEMORANDUM BOOKS, F. Greenslade, Weston-super-Mare.
24,954. CARBURETTERS for MOTORS, L. Campbell, Manchester.
24,955. IRONING MACHINE, A. E. Hacking and J. Pycroft, Birmingham.
24,956 SUPPORTING ARTISTS' PAINT BOXES, F. Mayor, Sheffield.
24,957. ELEVATING GEAR for ROLLING MILLS, Steel, Peech and Tozer, Limited, and M. H. Allott, Sheffield.
24,958. SUSPENDING CYCLE LAMPS, S. C. Perryman, Birmingham.
24,959. TIN BOXES, G. W. Rowe, Manchester.
24,960. ORIENTAL or TUFTED CARPETS, R. L. Sandeman, London.
24,961. METER-REGISTERING MECHANISM, A. McDonald, London.
24,962. TUBE CLEANERS, H. L. Greene, J. Zilliox, and M. H. Holmwood, London.
24,963. CLEANSING APPARATUS, G. W. and S. G. Jones, London.
24,964. SUSPENDING ARTICLES from TENT-POLES, A. T. W. McCaul, London.
24,965. COCKS for GAS IGNITING, F. S. Grunfeld, London.
24,966. INDIA-RUBBER SUBSTITUTE, L. H. and T. G. Jacobs and C. S. Brockwell, London.
24,967. PLATE RACK for KITCHEN RANGES, H. E. Fowler, London.
24,968. CARDS for ADVERTISING PURPOSES, R. C. Baker, London.
24,969. ADVERTIPHONE, W. F. C. Wallis and H. C. Mitchell, London.
24,970. BOOTS, J. Fergusson, London.
24,971. DRIVING MECHANISM, T. L. Bainbridge, London.
24,972. PREVENTING LIQUIDS IGNITING, N. W. Van Westerborg, London.
24,973. APPARATUS for CLEANING KNIVES, C. R. Brown, London.
24,974. VARIABLE SPEED GEAR, Budapesti Malomépitészot és Gépgyár, Podvinecz és Heisler and I. Beduch, London.
24,975. GAS BURNER APPARATUS, J. H. Bennet, London.
24,976. STEAM GENERATORS, B. B. Hill, London.
24,977. LETTER-COPYING APPARATUS, A. D. Klaber, London.
24,978. MAGAZINING and TRANSPORTING CARBONIC ACID, A. Wultze and Gebrüder Heyl G. m. b. H., London.
24,979. BURNING LIQUID FUEL, J. C. Merryweather, London.
24,980. REGULATING SUPPLY of GASEOUS FUEL, J. Junk, London.
24,981. MOTOR CARS and MOTOR TRICYCLES, A. Sharp, London.
24,982. CYCLE FRAMES, A. Sharp, London.
24,983. SHELLS, W. Strickland, London.
24,984. FRICTION CLUTCH MECHANISM, G. A. Parnes, London.
24,985. MOTOR CYCLES, J. A. Prestwich, London.
24,986. APPARATUS for PRESSING GAS, W. T. Sugg, London.
24,987. FLASH-LIGHT, H. E. Newton.—(*Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
24,988. COVERS for PNEUMATIC TIRES, C. Watkins, London.
24 989. ANTI-FOULING and PRESERVATIVE PAINT, G. G. Schobert, Birmingham.
24,990. MANUFACTURE of ALKYL ACIDS, O. Imray.—(*Farbenfabriken vormals Meister, Lucius, and Brüning, Germany.*)
24,991. APPARATUS for CALENDERING and like OPERATIONS, A. A. Whitley, J. Nuttall, and G. Bentley, London.
24,992. LADIES' SKIRT SUSPENDERS, C. W. Martin, London.
24,993. APPARATUS for CONVEYING and PILING TIMBER, J. Southern, T. Wintringham, and S. H. Wills, London.
24,994. FERMENTATION and CLARIFICATION of ALCOHOLIC LIQUIDS, A. Van de Kerckhove and A. A. L. J. Lebbe, London.
24,995. RETTING FLAX, W. M. G. Thomson, J. Shearer, and C. O'Brien, Dundee.
24,996. POWER GENERATING APPARATUS, H. Duffield, London.
24,997. WET-PRESS APPARATUS for PAPER MACHINES, A. Scheufelén, London.
24,998. SPRINGS for VEHICLES, C. Vermot, London.
24,999. SPEED INDICATOR for AUTOMOBILES, C. Caille, London.
25,000. MANUFACTURE of MEDICINAL CAPSULES of GLUTEN, C. Cornu, London.
25,001. HAY-MAKING MACHINES, J. Jackson, London.
25,002. SHIPPING COALS, Sir W. G. Armstrong, Whitworth and Co., Limited, and R. Wright, London.
25,003. PROPULSION of TORPEDOES, Sir W. G. Armstrong, Whitworth and Co., Limited, and W. H. Sodeau, London.
25,004. STEAM BOILER SUPERHEATERS, F. J. Cole, London.
25,005. TRANSMISSION GEARS, T. S. James, London.
25,006. CARBURETTERS for EXPLOSION MOTORS, H. W. Toms, London.
25,007. PNEUMATIC TIRES, A. and S. J. Woodhouse, London.
25,008. NON-REFILLABLE BOTTLES, J. Creasy and T. Smith, London.
25,009. PRESERVING EDIBLES, W. S. Simpson, London.
25,010. PRODUCING NITRIC ACID by ELECTRICITY, Westdeutsche Thomasphosphat-Werke Gesellschaft mit Beschränkter Haftung London.
25,011. MECHANICALLY-FEEDING HYDRAULIC PRESS-PLATE PRESSES, W. P. Thompson.—(*G. and E. Köbers, Germany.*)
25,012. SAFETY FASTENERS, E. Winterwerber, Liverpool.
25,013. PIPE JOINTS, L. Crompton, Liverpool.
25,014. CURLING IRONS, R. Kummer, Liverpool.
25,015. PREVENTING SIDE-SLIP in PNEUMATIC TIRES, W. Bentley, Liverpool.
25,016. TOBACCO PIPES, J. Souheur, London.
25,017. DISCHARGING DISINFECTANTS into FLUSHING TANKS, A. J. Day, London.
25,018. SADDLES for SUPPORTING TILES, J. Nicklin, London.
25,019. PLAITING LADIES' BELTS, C. Boden and H. M. Knight, London.
25,020. ACETYLENE MINERS' LAMP, P. Wolf, London.
25,021. PNEUMATIC TIRES, O. Albrecht, London.
25,022. SPRINGS, J. Lemp, London.
25,023. PERMANENT WAY of RAILWAYS, E. Gascard, London.
25,024. INFANTS' FEEDING BOTTLES, F. W. Perle, London.
25,025. FOLDING TABLE, M. Steinert, London.
25,026. ELECTRIC SWITCH MECHANISM, The British Thomson-Houston Company, Limited. — (*The General Electric Company, United States.*)
25,027. ELECTRIC SWITCH MECHANISM, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
25,028. AUTOMATIC FIRE-ARMS, W. J. Whiting, Birmingham.

18th November, 1904.

25,029. POTENTIOMETER APPARATUS for LOCALISING POSITION of FAULTS in ELECTRIC WIRES, T. Moore, Leeds.
25,030. ATTACHMENT to RIFLE for CUTTING WIRE, A. Wallis, London.
25,031. CARRIAGE DOOR LOCKS, C. E. Harrison, Birmingham.
25,032. PASSAGE CURTAIN ROD, M. E. Tomlinson, Kingston-upon-Hull.
25 033. HOLLOW BASS BAR, E. Withers, London.
25,034. BRICKMAKING MACHINERY, S. Shepherd, jun., Sheffield.
25,035. AEROGRAPH APPARATUS for ARTISTS, A. Coupe, Manchester.
25,036. LAMPS for INVERTED GAS, L. Liais, Manchester.
25,037. VARIABLE CAPACITY CHAMBERS, T. Thorp, Manchester.
25,038. LOOSE SOCKET JOINT, H. Sparrow, Wednesbury, Staffs.
25,039. CARRYING INSTRUCTION CARD on CYCLE, L. J. Kirkham, Sheffield.
25,040. SPRING CLIPS for NEWSPAPER FILES, H. Stone and Son, Limited, and L. W. Stone, Banbury.
25,041. TROLLEY HEADS for ELECTRIC TRAMWAYS, W. Knecn, London.
25,042. UPRIGHT POLE for SUPPORTING TENTS, A. Barr, Glasgow.
25,043. WATER VALVE for HOSE ATTACHMENT, J. Pinkerton, Glasgow.
25,044. HINGED BRIDGES, W. Fulton, Glasgow.
25,045. BAFFLING DOWN-DRAUGHT to GAS STOVES, G. H. Baldry, Bristol.
25,046. PETROL MOTORS, C. E. Simms and E. J. Blakemore, London.
25,047. HORSES' NOSEBAGS, R. Robinson, Sheffield.
25,048. NECKTIES, A. G. Malson, Sheffield.
25,049. CLIP for SUPPORTING LIGHT ARTICLES, A. E. Osborn, Plymouth.
25,050. REMOVING SEAL on DIP PIPES of GAS RETORTS, H. Townsend, Wakefield.
25,051. HANDLING LOADS, T. and O. J. Meacock, London.
25,052. MOTOR CAR DUST CONDENSER, G. Coddington, Burton-on-Trent.
25,053. MOTOR TIRES, H. C. Shalten, London.
25,054. OUTSIDE SEATS of TRAMCARS, W. S. Page and J. W. Morrison, Manchester.
25,055. PURIFIERS, G. Briddon, Manchester.
25,056. POSTCARD PRINTING MACHINES, E. Graber, Tunbridge Wells, Kent.
25,057. MANUFACTURE of SASH PULLEYS, A. D. Tipper, Wolverhampton.
25,058. STEREOTYPING, M. Smith, Reddish, near Stockport.
25,059. SCREW BOLTS and NUTS, E. Summerfield, Southampton.
25,060. MANUFACTURE of CHAINS, E. J. Perry, Birmingham.
25,061. MANDOLINES, A. L. Copeland, Manchester.
25,062. STAIR RODS and EYES, J. A. Richards, Birmingham.
25,063. LUBRICATORS, Perry and Co., Limited, and J. W. Bayliss, Birmingham.
25,064. CYCLE SADDLES, J. B. Brooks and J. Holt, Birmingham.

25,065. CRUMB SWEEPERS, O. W. Haydon, Birmingham.
25,066. DRAWING INSTRUMENTS, J. Tough, Birmingham.
25,067. AERATING and DRAINING FILTER BEDS, W. Oates, Halifax.
25,068. MOTOR CYCLES, A. A. Scott, Bradford.
25,069. MOTOR-DRIVEN TRI-CARS, W. F. C. Ward, Beckenham, Kent.
25,070. SANITARY PAPER HOLDERS, J. Barnes, Harrow.
25,071. BOTTLING of AERATED LIQUIDS, R. N. Dodd, Liverpool.
25,072. TERMINALS for ELECTRIC MAIN SWITCHES, J. R. Craig, jun., Glasgow.
25,073. COMBINED GRIPPER and EXPANDER, H. Frankenburg, Birmingham.
25,074. MEANS for CONNECTING DRAFT TRACES, D. Bird, Birmingham.
25,075. FOG SIGNAL, F. Self, London.
25,076. COMPOUND of COFFEE and MILK, J. R. Hatmaker, Paris.
25,077. DRYING BLOOD and FLUID EXTRACTS, J. R. Hatmaker, Paris.
25,078. ELECTRIC IGNITION DEVICES, E. Aron.—(*L. Boulez, France.*)
25,079. APPARATUS for MAKING MILK, G. Kunich, London.
25,080. INVERTED INCANDESCENT GAS LAMPS, M. Kay, London.
25,081. FASTENING for BROOCHES, C. M. MacGeorge, Sutton, Surrey.
25,082. WATCHES, L. Grissl, London.
25,083. AUTOMATIC PIANO PLAYERS, F. Wilkinson and H. B. Swift, London.
25,084. SELF-PROPELLED ROAD VEHICLES, E. E. Lehwess, London.
25,085. SECURING RAILWAY RAILS to SLEEPERS, R. R. Calthrop, London.
25,086. COAL-CUTTING MACHINES, G. W. Bousfield, H. M. Lane, and M. W. Robinson, London.
25,087. TOOL-CARRYING CHAINS for COAL-CUTTING MACHINES, G. W. Bousfield, H. M. Lane, and M. W. Robinson, London.
25,088. MOTOR CYCLE FRAMES, J. Pollitt and H. Smith, Coventry.
25,089. TABLES with FOLDING SUPPORTS, P. H. Ayres and W. H. Kabarens, London.
25,090. DEVICES for MARKING BOOTS, E. J. Passingham, London.
25,091. FOUNTAIN PENS, A. M. Flack.—(*J. W. Williams, United States.*)
25,092. WRITING INK, A. M. Flack.—(*J. W. Williams, United States.*)
25,093. FENCING, C. R. Lloyd, London.
25,094. ALARM CLOCK and PHONOGRAPH, J. A. Wozencraft, London.
25,095. ELECTRIC ACCUMULATORS, E. W. Jungner, London.
25,096. BOTTLES, E. Haupt, London.
25,097. HINGES, W. H. Wilson, London.
25,098. PACKING for GLASS PLATES, A. J. Leaper, London.
25,099. MOUNTING STEREOTYPES and ELECTROTYPES, J. A. Corey, London.
25,100. FISHING REELS, A. G. Bessemer, jun., and T. Petersen, London.
25,101. AUTOMATICALLY-OPERATED MUSICAL INSTRUMENTS, I. B. Smith, London.
25,102. A NEW TIN-OPENER, F. Nusch.—(*C. Bernard, France.*)
25,103. SAFETY LOCKS, J. Baum and J. Lenker, London.
25,104. LUMINOUS ATTRACTIONS, F. Nusch.—(*M. Mortet, France.*
25,105. DEVICE for DISTINGUISHING between the POLES of an ELECTRIC CIRCUIT, H. G. Prested, London.
25,106. REGULATING ELECTRIC CURRENT, H. G. Prested, London.
25,107. MANUFACTURE of SULPHO-CYANIDE, J. Tchernisc, London.
25,108. COIN-CONTROLLED MACHINES, R. Wales, London.
25,109. DISPLAY STAND for BRUSHES, L. E. Jordan, London.
25,110. HOOF-PADS for HORSES, W. Barber and R. Spanton, London.
25,111. SPINNING and DOUBLING PROCESSES, S. Z. de Ferranti, London.
25,112. ELECTRIC LIGHT SYSTEMS, H. H. Lake.—(*C. A. Gould, United States.*)
25,113. COIN-FREED GAS METERS, B. R. Beale, London.
25,114. ELECTRIC ACCUMULATORS, J. M. de la Croix and H. F. Joel, London.
25,115. HEATING RUBBER TIRES, W. B. Lake and E. F. Elliot, London.
25,116. SEPARATING GOLD from other MATERIAL, G. Moare, London.
25,117. SCREW WRENCHES, V. Eiselt, London.
25,118. SAFETY DEVICE for TRAINS, M. Knorn, London.
25,119. SCREW-THREADED TENONS, C. M. White.—(*J. A. Wilkinson, United States.*)
25,120. FURNITURE, C. M. White.—(*J. A. Wilkinson, United States.*)
25,121. CHAIRS, C. M. White.—(*J. A. Wilkinson, United States.*)
25,122. BENT WOODEN PARTS, C. M. White.—(*J. A. Wilkinson, United States.*)
25,123. BARBERS' CHAIRS, C. M. White.—(*J. A. Wilkinson, United States.*)
25,124. CHAIRS, C. M. White.—(*J. A. Wilkinson, United States.*)
25,125. CHAIRS, C. M. White.—(*J. A. Wilkinson, United States.*)
25,126. VENETIAN BLINDS, D. W. Wells, London.
25,127. MOULDING CANDLES, W. H. Day and W. Murch, London.
25,128. ELECTRICALLY INSULATING MATERIAL, U. Marga, London.
25,129. ELECTRIC BRAKING APPARATUS, W. P. Thompson.—(*L. Stamm and E. D. Lewis, United States.*)
25,130. DEVICE for SEALING JARS, J. G. Shearer, Liverpool.
25,131. BLOUSE ADJUSTERS, A. Jones and R. J. and M. Roberts, Liverpool.
25,132. APPARATUS for GAME of SKILL, E. L. Evans, Liverpool.
25,133. SEWING MACHINE MECHANISM, A. Laubecher, London.
25,134. SPINNING PROCESSES, S. Z. de Ferranti, London.
25,135. DOUBLE-ACTING SPRING HINGES, E. Bommer, London.
25,136. DARK SLIDES for PHOTOGRAPHY, H. H. Crosbie, London.
25,137. BOX FASTENINGS, Sir B. Scott and D. Taylor, London.
25,138. CLOSING LIDS of RETORTS, A. Hilson and A. J. Wilton, London.

19th November, 1904.

25,139. HOLDER for CURTAIN POLES, H. A. Schmitz, Cologne, Germany.
25,140. VENTILATORS, W. C. Morison, Wolverhampton.
25,141. WEIGHING MACHINE, J. Dobson and H. Pooley and Son, Limited, Birmingham.
25,142. ETHYL CHLORIDE INHALERS, A. Browne, Leicester.
25,143. HAT WIRE, W. H. Johnson and T. Heys, Manchester.
25,144. LADIES' MOTOR DRIVING COAT, I. Finberg, London.
25,145. LOCKS for TRAVELLING TRUNKS, A. Bates, Wolverhampton.
25,146. GOLF CLUBS, J. R. Brown, Glasgow.
25,147. REVOLVING SPRINKLERS, J. Bolton and M. W. Mills, Manchester.
25,148. PORTABLE OVEN WAGONS, F. White and W. J. Jackson, Manchester.
25,149. GOVERNOR for MARINE ENGINES, T. Fordyce, Glasgow.
25,150. FIXING SPOUTS to KETTLES, E. Stevens, Birmingham.
25,151. MACHINE for DIGGING POTATOES, J. Ball, West Kirby.
25,152. DRAUGHT PREVENTER, T. Thornton, Bury, Lancs.
25,153. BRUSH, J. Adderley, Longton, Staffs.
25,154. TABLE ATTACHMENT for BEDSTEADS, G. L. Harrison, Stockton-on-Tees.
25,155. DISPLAYING ADVERTISEMENTS, J. Dyson, Manchester.
25,156. REFUSE DESTRUCTORS, F. Wellerman, Manchester.
25,157. INTERNAL COMBUSTION ENGINES, J. W. Seal, London.
25,158. INSOLE for BOOTS, H. MacKintosh, G. A. Stewart, and D. M. MacKenzie, Glasgow.
25,159. FIREPLACE, A. H. Cotn, Stoke-on-Trent, Staffs.
25,160. COKE CONVEYORS, A. W. Bennis, Manchester.
25,161. INTERNAL COMBUSTION ENGINES, Sir J. W. Ottley and A. W. Brightmore, Egham, Surrey.
25,162. FIREPLACES, D. Russell, Leeds.
25,163. COATING SURFACES with GLASS, F. J. Clinch-Jones, Leamington Spa, Warwick.
25,164. BELTS for CONVEYING COAL, A. W. Storey, Manchester.
25,165. MORDANTING VEGETABLE FIBRES, The Calico Printers' Association, Limited, and W. Warr, Manchester.
25,166. TREATING VEGETABLE FIBRES, The Calico Printers' Association, Limited, and W. Warr, Manchester.
25,167. TREATING VEGETABLE FIBRES, The Calico Printers' Association, Limited, and W. Warr, Manchester.
25,168. SEALING BOTTLES, J. E. L. Barnes.—(*The Crown Cork and Seal Company, United States.*)
25,169. BOTTLE SEALS, J. E. L. Barnes.—(*The Crown Cork and Seal Company, United States.*)
25,170. BOTTLE SEALS, J. E. L. Barnes.—(*The Crown Cork and Seal Company, United States.*)
25,171. ELECTRIC LIGHT BATHS, J. Scott, Liverpool.
25,172. DYNAMO ELECTRIC MACHINES, S. T. Webster, Liverpool.
25,173. APPARATUS for WASHING CLOTHES, V. Lord, Manchester.
25,174. ANNEALING CAST IRON CYLINDERS, S. Wheldon, Manchester.
25,175. ELECTRICAL TIMING APPARATUS, G. Higginbotham, Manchester.
25,176. REFRIGERATORS, P. Robinson, Birmingham.
25,177. VIGNETTERS for PHOTOGRAPHIC FILMS, G. W. Morgan, Aberdeen.
25,178. TIP WAGONS, A. S. Nelson, London.
25,179. PIANO ATTACHMENT, A. Pattinson and J. Ross, Glasgow.
25,180. PRINTING TICKETS, D. Carlaw, sen., D. Carlaw, jun., and A. L. and J. W. Carlaw, Glasgow.
25,181. ELECTRIC LAMPS, C. P. J. Fitzsimon, Dublin.
25,182. SCREW NUT SECURER, F. van Thial, Düsseldorf, Germany.
25,183. FASTENING BOOKS in CASES, J. P. Petty, London.
25,184. APPARATUS for DEALING PLAYING CARDS, C. Tuckfield and W. G. de F. Garland, East Molesey, Surrey.
25,185. PRODUCING INCANDESCENT GAS LIGHT, E. Salzenberg, London.
25,186. DEVICE for GIVING WARNING when TIRES BECOME DEFLATED, H. Hunt, London.
25,187. DURABLE STREET PAVEMENTS, J. von Prunkl, London.
25,188. DRAUGHT MECHANISM of WAGONS, G. Hoare London.
25,189. COMPOSITION for ELECTRIC CONDUITS, R. Starke, London.
25,190. ACETYLENE GAS GENERATORS, C. H. Worsnop, Halifax.
25,191. COHERER for ELECTRIC TRANSMISSION, G. Magini, London.
25,192. PNEUMATIC BRAKES, J. W. Cloud, London.
25,193. APPLIANCE for HOLDING CYCLES, A. J. Hands, Birmingham.
25,194. OIL STOVES, H. Cole, Birmingham.
25,195. MARINE GOVERNOR for STEAM ENGINES, P. J. Perry, Leytonstone, Essex.
25,196. POWER FACTOR of ALTERNATING CURRENT CIRCUITS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
25,197. VENTILATION for CAPS, R. Rowley and J. Kalmanowitch, London.
25,198. ENEMAS, J. J. Purdie, London.
25,199. INTERNAL COMBUSTION TURBINES, F. Windhausen, London.
25,200. FUNNELS, E. Hillam, London.
25,201. GUN MOUNTINGS, Sir W. G. Armstrong, Whitworth and Co., Limited, and A. G. Hadcock, London.
25,202. PRINTING, C. Janzer, London.
25,203. EXPANSIBLE LEDGERS, T. R. Dewell, London.
25,204. SEPARATING SOLID PARTICLES, A. P. S. Macquisten, London.
25,205. CARBURETTERS, J. A. Torrens, London.
25,206. FLY-CATCHERS, O. Tewes and W. Pietsch, Liverpool.
25,207. PREPARATIONS for REMOVING HAIR, J. B. Leatherbarrow, Liverpool.
25,208. DYEING, &c., TEXTILE MATERIALS, L. Détré, London.
25,209. ENDLESS CONVEYORS, H. H. G. Etcheverry, London.
25,210. DRIVING ARRANGEMENTS for MOTOR CARS, R. Schwenke, London.
25,211. CONTRIVANCE for PRACTISING SHOOTING, F. Courtinade, London.
25,212. CARBURETTERS, F. W. Howorth.—(*Akt.-Ges. vorm. F. Martini and Co., Switzerland.*)
25,213. TREATING GASES, A. W. Mathys.—(*J. Gayley, United States.*)
25,214. MACHINES for EXPANDING SLITTED SHEETS, H. H. Lake.—(*L. E. Curtis and O. Bradford, United States.*)
25,215. SHOCK-DEADENING BRAKE for VEHICLES, T. Bergmann, London.
25,216. APPARATUS for MAKING SOLUTIONS, J. W. Mackenzie.—(*J. U. Lloyd, United States.*)
25,217. SAND-BOX, E. von Planta, London.
25,218. ENCLOSED ELECTRO-MAGNET, D. Perret, London.
25,219. PROTECTIVE SYSTEMS for ELECTRIC DISTRIBUTION LINES, L. Wilson, London.
25,220. PROTECTIVE SYSTEMS for ELECTRIC DISTRIBUTION LINES, L. Wilson, London.
25,221. MANUFACTURING PURE LACTIC ACID, A. J. Boult.—(*C. H. Boehringer and Sohn, Germany.*)
25,222. ROTARY PUMPS, H. Handoll and R. J. White, London.
25,223. GAME, W. J. Hogben, London.

21st November, 1904.

25,224. MATTRESSES, D. P. Edwards, jun., Cardiff.
25,225. WASTE PREVENTING VALVE for WATER SUPPLY, G. A. Becks, London.
25,226. MEAT VANS, The Metropolitan Amalgamated Railway Carriage and Wagon Company, Limited, and A. E. Morgan, Birmingham.
25,227. BRICK KILNS, J. Hamblet, Birmingham.
25,228. HAMMERS, E. H. Hill, Sheffield.
25,229. LININGS of ROTARY PUMPS, C. and A. Hillier, Birmingham.
25,230. WINDOW CLEANER, A. Williams, Redditch, Worcester.
25,231. BUFFERS of SHUTTLE BOXES of LOOMS, H. Taylor, Halifax.
25,232. PINCH-GRIP BUCKLES, T. A. Smith, Birmingham.
25,233. MACHINES for FINISHING FELT HAT BODIES, R. J. C. Mitchell and J. Eaton, Manchester.
25,234. ROLLERS for FINISHING FELT, R. J. C. Mitchell and J. Eaton, Manchester.
25,235. IGNITION PLUGS, J. T. Taylor and W. Lawson, Middlesbrough, Yorks.
25,236. BOX and SAD IRONS, J. Evans, Wolverhampton.
25,237. STOPPING PROPELLER DRIVEN BY EXPLOSIVE, A. H. Webber, Great Yarmouth.
25,238. ATTACHING STOPPERS to BOTTLES, J. W. Dawson, Glasgow.
25,239. ELASTIC BRACES, J. F. Hurst, Manchester.
25,240. ORGAN SWELL-BOX SHUTTER OPENER, L. J. Boyd and J. H. Ryan, Dublin.
25,241. RANGE FINDERS, C. and H. C. Beck, London.
25,242. BUTTON HOLES for SHIRT CUFFS, J. Masters, Manchester.
25,243. SYSTEM of TELEPHONES, H. B. Stocks, Manchester.
25,244. GAUGES for CARPENTERS, C. Horsman, Birmingham.
25,245. APPLYING COLOURS to PICTURES, J. Linnett, jun., Coventry.
25,246. HOLDER for HEADACHE PENCILS, H. Engelhardt, Cologne, Germany.
25,247. MEANS for EXTINGUISHING FIRE, W. Miller, Glasgow.
25,248. ELECTRIC IGNITION APPARATUS, W. C. Priestley and B. Holroyd, Leeds.
25,249. ELECTRIC SWITCHES, E. Talbot and D. Mondey, Sheffield.
25,250 CASES for PACKING BOTTLES, H. J. S. Brown, London.
25,251. OIL BOX, J. Wood, Manchester.
25,252. PRINTING TEXTILE FABRICS, W. Spears, Manchester.
25,253. VAPORISER, R. G. Bickerton and J. Gunnill, Goole.
25,254. BICYCLE BRAKE, J. A. Cavanagh, Abbeyleix, Queen's Co., Ireland.
25,255. AUTOMATIC GAS-LIGHTER, Gesellschaft für Farbenfabrikation m. b. H. and A. Rosenberg, London.
25,256. GRAMOPHONE SOUND BOXES, R. S. Eckhardt and C. J. W. Hadson, London.
25,257. SEED PLANTERS, J. M. Roberts, London.
25,258. FURNACES for BOILERS, W. G. Potter, London.
25,259. CHANGE and TICKET VEST, F. A. Kress and R. Long, London.
25,260. ADJUSTABLE CHECK VALVE for FLUIDS, J. Peschek, London.
25,261. TOBACCO PIPES, A. Dunhill, London.
25,262. COMBINATION COVER, H. V. Letts, London.
25,263. BOTTLE STOPPERS, G. R. Martin and H. T. Harrison, London.
25,264. SHIELDS for PNEUMATIC TIRED WHEELS, W. and W. H. Shaw, Birmingham.
25,265. STORAGE BATTERY, A. J. Roult.—(*Accumulatoren und Electricitäts-werke-Act.-Ges. vormals W. A. Boese and Co., Germany.*)
25,266. BOOT MACHINERY, W. Heaton, London.
25,267. BOOK-STANDS, E. Parker, London.
25,268. GEAR WORK of BICYCLES, F. Elkington, Romford, Essex.
25,269. ROTARY ENGINES, J. H. Corthesy and G. F. Griffin, London.
25,270. SOLDER for ALUMINIUM, P. J. Jackson, London.
25,271. EGG BEATER, E. M. Morgan, London.
25,272. CIRCULATING LIQUIDS in TANKS, G. E. Dunton, London.
25,273. HAIR NET, B. J. B. Mills.—(*J. Gibuet, France.*)
25,274. CLOSETS, D. T., F. J., and E. Bostel, London.
25,275. CUTTING BEVELLED TOOTHED WHEELS, E. Dubosc, London.
25,276. VAPOUR ELECTRIC LAMPS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
25,277. VARIABLE-SPEED DRIVING MECHANISM, W. C. Lea, London.
25,278. GRAVITY BUCKET CONVEYORS, M. Graham, London.
25,279. HORSE ACTUATED BRAKE, A. W. Gillum, Birmingham.
25,280. ACETYLENE LAMPS, G. Polkey and G. Polkey, Limited, London.
25,281. PURIFYING FEED-WATER, J.-B. Lemaire-Destombes, London.
25,282. ELECTRODE, Siemens and Halske Akt.-Ges., London.
25,283. COUPLING for HOSE PIPES, R. G. McDowell, London.
25,284. DISCHARGE of DYED TEXTILE FABRICS, J. Y. Johnson.—(*Badische Anilin and Soda Fabrik, Germany.*)
25,285. WASH-BASINS, C. A. James, London.
25,286. SADDLES, J. Richard, London.
25,287. MACHINES for WASHING BOTTLES, E. E. Hanna, London.
25,288. PEDALS, E. Germaine and L. C. Hacusser, London.
25,289. BUILDING BLOCKS, T. Podmore, London.
25,290. SELF-ACTING WASHING MACHINES, F. Hill, London.
25,291. APPLYING FLY-LEAVES to END SIGNATURES of BOOKS, W. P. Thompson.—(*W. L. Lewis, United States.*)
25,292. WATERPROOF TROUSERS, G. J. L. Coustou, London.
25,293. LIGHTING GAS by CLOCKWORK, C. C. Wildschiodtz, London.
25,294. CHANGE SPEED GEAR for CYCLES, C. H. Butlin, London.
25,295. SPEED CHANGING MECHANISM, H. G. Giffard, London.
25,296. PREPARING ARTIFICIAL SILK, F. Todtenhaupt, London.
25,297. MARKING "HANDS" in CARD GAMES, A. W. S. Pocklinton, London.
25,298. SACKS, G. Leue, London.
25,299. WATER METERS, W. G. Volz, Liverpool.
25,300. MECHANICAL ADVERTISING, T. Kosugi, London.
25,301. ELASTIC TIRES for WHEELS, J. S. Smith, London.
25,302. ABACUS for TEACHING ARITHMETIC, J. T. Reeve, London.
25,303. SEWING CIRCULAR PORTIONS of FABRIC, F. Wever, London.
25,304. WARMING RAILWAY CARRIAGES, N. J. Raps, London.
25,305. REINFORCING STUDS, B. L. D'Aubigné, London.
25,306. SYRINGES, A. J. Boult.—(*M. O. Groh, Germany.*)
25,307. VOMITING KIERS, A. J. Boult.—(*E. D. Jefferson, United States.*)
25,308. GAS for MANUFACTURING PURPOSES, G. Gauthier, London.
25,309. METHOD of "TARRING" BROKEN SLAG, E. P. Hooley and The Tar Macadam (Purnell Hooley's Patent) Syndicate, Limited, London.
25,310. PROTECTED EARTHENWARE COCKS, C. Ruppel, London.
25,311. ORDER and INVOICE FORMS, R. Thompson, London.
25,312. SLABS for RETURN ENDS of STEPS, J. Rule, London.
25,313. CYLINDERS for STEAM ENGINES, R. Eltringham, London.
25,314. PLANT for SCREENING REFUSE, H. G. Trudgett, London.
25,315. COLLAPSIBLE FRAMEWORK for TENTS, B. T. Wrinch, London.
25,316. VEGETABLE SERVERS, S. Harwarth, London.
25,317. LAMPS for MOTOR VEHICLES, W. H. Croker, London.
25,318. PRINTING ROLLERS, J. H. Stark and C. G. Barcus, London.
25,319. TRANSMISSION GEARING for MOTOR VEHICLES, A. H. Crockford, London.
25,320. FURNACE for ANNEALING SHEET METAL, O. Müller, London.
25,321. TIRES for WHEELS of VEHICLES, A. A. Gellynck, London.
25,322. WHEELS for ROAD VEHICLES, H. S. Halford, London.
25,323. PENCILS, J. D. R. Lamson, London.
25,324. TAP-HOLE STOPPER for BARRELS, A. Cousen, London.
25,325. TAP-HOLE CLOSURE for CASKS, A. Cousen, London.
25,326. YARD for MEASURING CLOTH, J. W. Mackenzie.—(*O. Forsmann, Sweden.*)

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25,327. PREVENTING DRAUGHT through DOORS, E. R Barnett, Birmingham.
25,328. ADJUSTABLE SCROLL, H. V. Holmes, Liverpool.
25,329. ELECTRICAL MEASURING INSTRUMENTS, W. C. Fisher, West Ealing, Middlesex.
25,330. FANLIGHT OPENERS, H. Hawgood, Eccles, near Manchester.
25,331. ELECTROLYTIC CELLS, J. Hargreaves, Farnsworth-in-Widnes, Lancs.
25,332. CLOTH STEAMING APPARATUS, J. Hollings, Bradford.
25,333. WINDOW SASH CORD FASTENERS, R. C. Ross, Dundee.
25,334. FITTINGS for WINDOWS, W. L. Hamilton, Glasgow.
25,335. REPAIRING INDIA-RUBBER TIRES, R. A. Smith, Manchester.
25,336. LAMPS, G. Wilkinson, Halifax.
25,337. CONDIMENT RECEPTACLES, E. Hitch, Birmingham.
25,338. TOOLS for WOOD-WORKING, S. C. Foley, Blackburn, Lancs.
25,339. DOOR HOLDERS, E. G. May, Glasgow.
25,340. BELT FASTENERS, I. Jackson, Manchester.
25,341. LOWERING of MUSIC STOOLS, J. Ashworth, Hyde, Cheshire.
25,342. WIRE MATTRESSES, R. P. Taunton, Birmingham.
25,343. PADS for FELT HAT POUNCING MACHINES, E. Gaeer, A. Turner, and Turner, Atherton and Co., Limited, Manchester.
25,344. APPARATUS for MINERS' TRAMS, W. Galloway, Bristol.
25,345. FIXING HANDLES to BROOMS, P. R. Taylor, Liverpool.
25,346. NAILS, A. Chandler, Birmingham.
25,347. EJECTOR MECHANISM for SMALL-ARMS, T. D. Cross and H. Jones, Birmingham.
25,348. MANUFACTURE of PNEUMATIC TIRES, A. E. Beck, Earlswood, Warwick.
25,349. INTERNAL COMBUSTION ENGINES, A. E. Beck, Earlswood, Warwick.
25,350. SASH FASTENERS, J. E. Leatherland, Birmingham.
25,351. NON-REFILLABLE BOTTLES, J. H. Thomas, Liverpool.
25,352. COAL HOISTS, G. L. Scott, jun., and W. Hodgson, Manchester.
25,353. ADJUSTABLE HANDLE-BAR, F. Smith, Glasgow.
25,354. MANUFACTURE of SULPHATE of IRON, W. Garroway, Glasgow.
25,355. NON-REFILLABLE BOTTLES, G. Audley, T. K. Crossley, and G. Jones, jun., Liverpool.
25,356. FEED PUMPS, J. C. Harrison, Bowness-on-Windermere, Westmorland.
25,357. AUTOMATIC WEIGHING MACHINES, W. E. Hipkins and C. F. Beakbane, Birmingham.
25,358. WEIGHING MACHINES, W. E. Hipkins, Birmingham.
25,359. SHAFTS for PERAMBULATORS, W. G. Maury, Leeds.
25,360. MOTOR CAR HORNS, A. Dunhill, London.
25,361. APPARATUS for STEAM GENERATORS, R. P. Roy, London.
25,362. SIDE TIPPING WAGONS, D. Stewart and Co. (1902), Limited, and T. Wishart, London.
25,363. TRAMWAYS, W. E. Kenway, London.
25,364. DEVICE for BENDING TUBES, E. Fröhlich, Cologne Germany.
25,365. TWIN SCREW PUMPS, W. H. Robinson, London.
25,366. ASH TRAY for RAILWAY VEHICLES, J. T. Reade, Belfast.
25,367. ARTICLES of WEARING APPAREL, S. P. Farmer, London.
25,368. APPARATUS for VULCANISING TIRE COVERS, H. H. Frost, London.
25,369. PRODUCTS for MEDICAL USE, W. H. Williams.—(*C. von Forell, Germany.*)

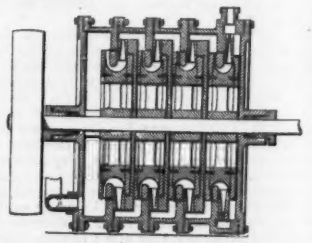
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

770,736. ELASTIC FLUID TURBINE, *W. J. Cartwright, New York, N.Y.—Filed May 10th*, 1904.

Claim.—(1) An elastic fluid turbine having a wheel provided with buckets, such buckets having their inlets of greater area in cross section than their outlets, and an expansion nozzle arranged to deliver the elastic fluid to such buckets. (2) An elastic fluid turbine having a wheel with compression buckets, the walls of said buckets at the outlets being

770,736

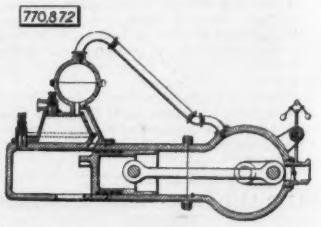


flexible to close the outlets under external pressure. (3) An elastic fluid turbine comprising a wheel formed with a peripheral channel and plates dividing said channel into buckets, said plates being extended beyond the rim of the wheel and flexible to close the outlets of the buckets under external pressure.

770,872. EXPLOSIVE ENGINE, *H. Söhnlein, Wiesbaden, Germany.—Filed October 4th*, 1899.

Claim.—(1) An explosion engine, comprising a cylinder, its piston dividing the same into explosion and pumping chambers, a source of explosive fluid supply and a receiver in perpetual communication with said source of supply and with the pumping chamber of said cylinder, and piston-controlled admission and exhaust ports in communication with the receiver and the atmosphere respectively, said parts organised to cause a charge of explosive fluid to flow

770,872



from said source of supply to and expand in the receiver on the instroke of the piston, to compress said charge and admit it to the explosion chamber at or about at the completion of the outstroke of the piston and simultaneously uncover the exhaust port, whereby the inflowing compressed charge of explosive fluid explanding into the explosion chamber serves to drive out the products of combustion, and is again compressed on the next instroke of the piston before ignition, for the purpose set forth.

RECENT LOCOMOTIVE WORK ON THE LONDON AND NORTH-WESTERN RAILWAY.

By CHARLES ROUS-MARTEN.

No. III.*

BEFORE leaving Mr. Whale's "Precursor" engines and their work, I should like to notice two instances which have come under my personal observation since writing my previous article. One of these engines, No. 659, Dreadnought, was on the 2 p.m. Anglo-Scottish Corridor Dining-car Express from Euston. I travelled in that train as far as Rugby. The load was officially reckoned as "19½ coaches," the total weight behind the tender, including passengers, luggage, staff, and stores, being approximately 390 tons. A considerable part of the run to Rugby was made dead in the teeth of a furious snow-blizzard, which kept the rails in a state of constant slipperiness; nevertheless the locomotive, although necessarily impeded, never seemed in even momentary difficulty. Starting from Willesden, Sudbury (2¼ miles) was passed in 4 min. 49 sec., a speed of 40 miles an hour having already been reached. The following 3¼ uphill miles to Harrow were covered in 4¼ minutes, and Bushey was passed precisely six minutes later, the distance between the two stations being 4¾ miles, and the average speed, therefore, 47·8 miles an hour. The short level length thence to Watford enabled a rate of 56·2 miles an hour to be reached, and the fourteen miles climb to the Tring summit was begun at that speed. It had fallen to 51·1 miles an hour at Langley, 50 at Boxmoor, and 47·4 at Berkhamsted, and finally dropped to 46·4 three miles short of the summit, but then it recovered, and a rate of 50 miles an hour was attained half a mile before the Tring summit was topped. The subsequent 20¼ miles, mostly on a slight downhill grade, occupied 20 min. 4 sec., the speed being kept at a very even and steady rate. Then came the 7 miles rise at 1 in 330 to 1 in 335 past Roade. Up this ascent our minimum rate was 49·5 miles an hour, and up the final bit of 1 in 340 to the Kilsby Tunnel 51·1. Rugby was reached in 87 min. 55 sec. from Willesden. Thus the run was made in five seconds less than booked time, in the teeth of a fierce snow-blizzard, and on an excessively slippery rail.

My return journey from Rugby was made with the 1.45 p.m. express, which is a huge combination of Liverpool, Manchester, Carlisle, Holyhead, Birmingham, and Leamington portions. In this case it totalled "21¼ coaches," and weighed approximately 412 tons behind the tender. The engine, of the "Precursor" class, was an old friend, No. 2, Simoom. I regret that I omitted to note who was the driver in this case, for he certainly handled the engine very skilfully under difficult conditions. Thus, in the first place, snow, frost, and mist prevailed, making the metals slippery; secondly, some ice got into the vacuum brake, preventing its being entirely taken off; thirdly, we had a permanent way slack near Blisworth; and fourthly, some of the tubes became choked during the ascent of the bank to Tring, which both retarded our ascent of the 1 in 330 grade, and also compelled the driver to shut off steam in order to blow them clear, after we had passed the summit, which brought down our speed to 50 miles an hour, when it should have been nearer 70. Nevertheless, so well did Mr. Whale's engine do its work that instead of any time being lost, as it well might have been in such circumstances with a load of 412 tons and no pilot assistance, Simoom actually gained 3¼ minutes on the 51½ miles an hour booking, making the run of 77 miles from Rugby to Willesden in 86 min. 44 sec., and thus averaging 53·3 miles an hour from start to stop. Leaving Rugby on an up grade of 1 in 364, we attained 40 miles an hour in three miles from the start. Up the 1 in 326 approaching Roade, the speed did not go below 52·8 miles an hour. Bletchley, 35¾ miles, was passed in 41 min. 58 sec. from Rugby. Up the bank to Tring a minimum rate of 47·4 miles an hour was maintained until the partial choking of the tubes already mentioned brought it down to 45, and finally to 42·8 in the last three miles to the summit. The downhill time to the Willesden stop from Tring was 26 min. 31 sec. for the 26¼ miles, 2 min. being lost as above described at the beginning of the descent. On the same day, No. 412, Marquis, of the same class—originally named Alfred Paget—kept time from Willesden to Blisworth on the 9.20 a.m. ex-Euston—the fastest booked train on the London and North-Western, in spite of the weather; but then the run was spoiled by signal delays, as was also the up-run of the same engine. Judging the "tree by its fruits," I do not hesitate to assert that Mr. Whale's new engines have abundantly justified their existence, and have also demonstrated with what certainty even the heavy and fast-timed London and North-Western expresses can be run with punctuality, if only a suitable type of locomotive be employed, and be made to do its work, and also how needless has been the long employment of assisting engines "up whose chimneys," as a very eminent engineer once observed, "the shareholders' dividends have so long been puffed."

I now come to the drastic change with which Mr. Whale has, at a stroke, converted certain members of a race of relative sluggards into active and efficient engines. I have used the more disparaging term in its relative sense, for I have found not only the larger "Alfred the Great" class of four-cylinder compounds, but also the earlier and smaller "Jubilee" class, do very good work at times with loads and speeds suited to their particular tastes. The misfortune was that these tastes had to be so studiously considered and indulged as to make it by no means easy to classify their duties. Thus in their original shape they would take a very heavy load at medium speed, or a light load at fairly high speed, but with a heavy load if booked at a really high average rate, *e.g.*, 54 to 57 miles an hour, they invariably—in my experience, and in that of many friends—failed to keep time, and so had to be assisted by pilots. When they had either a "Problem"—7ft. 6in. single—or a "Precedent"—6ft. 6in. coupled—in front, they did well enough. They did the pulling, and the pilots made the running; thus, between the two, punctuality was often achieved, but with loads only "8¼" to "12½" coaches—as officially computed—per engine, manifestly not an economical mode of working.

When the pioneer of Mr. Webb's four-cylinder compounds, named Black Prince, came out in 1897, the du Bousquet-de Glehn French compounds and their remarkable achievements were little known in this country, if at all; nevertheless, it was promptly recognised and pointed out that the new London and North-Western compounds laboured under two distinct disadvantages in comparison, viz.:—(1) The lack of a separate cut-off for the high-pressure and low-pressure cylinders; and (2) the plan of driving one axle with all four cylinders. It is this first-named drawback which the new chief at Crewe has set himself to remedy. He has done so by altering the valve gear so as to give a separate cut-off for the high and low-pressure cylinders.* A single reversing screw actuates both the high and low-pressure reversing shafts, either together or independently of one another, but the high-pressure and low-pressure reversing rods are coupled to a short beam, which is pivoted on a central pin that connects it to the main screw operated by the larger hand-wheel. Thus both high and low-pressure cylinders can be reversed by the one hand-wheel. But to each end of the beam a short rod is attached which slides in a recess in the bracket casting, and which can be locked in any position by means of a smaller hand-wheel and screw. Thus, when the engine has got well started with high and low-pressure reversing shafts in full forward gear, the end of the short beam which carries the low-pressure rod can be locked in that position by means of the small hand-wheel and screw. Then with the large hand-wheel and screw the other end of the beam, to which is attached the high-pressure rod, can be moved back as desired. In this way the travel of the high-pressure valves can be varied, while the low-pressure valves are left to work at their full travel. By another ingenious and simple provision the maximum angle required for each reversing shaft can be determined. It will thus be seen that the "notching-up," after the engine has got well under way, is done entirely in the high-pressure cylinders, while the low-pressure cylinders are left to use the full volume exhausted from the high-pressure cylinders, instead of being compelled in all instances to work at the same proportionate cut-off as the high-pressure, irrespective of the desirableness or otherwise of employing such uniformity of expansion in both cases. The experience of the de Glehn engines, at any rate, has entirely demonstrated the preferableness of a separate cut-off, and this has already been shown most conclusively by the experiences on the London and North-Western with the compounds that have thus been modified by Mr. Whale.

Of this I am in a position to adduce a strikingly cogent illustration. Bearing in mind that with their original valve gear these engines were required to take a pilot whenever their load exceeded a maximum reckoned as "17 coaches," whose total weight behind the tender might vary from 300 to 320 tons, and that this regulation had been rendered necessary by the frequent failures in punctuality, not merely with loads of 17 coaches and upward, but even sometimes with 16, 15, or even 14 coaches, apparently owing to the sluggishness with which the engines worked, it will be interesting to compare a recent experience of my own with one of the same class of locomotives as modified by Mr. Whale.

On a comparatively recent date I travelled specially from Rugby to Euston in the 1.45 p.m. express, to test the work of one of these converted compounds. The engine was No. 1941, Alfred the Great, the earliest-built of the later batch of forty, but I believe the latest up to that date to be converted by Mr. Whale to his own method. The load was a stupendous one, officially reckoned as "24½ coaches," and weighing—again according to official figures, by adding together the separate Wolverton weights of the individual vehicles—464 tons empty, or 485 tons including passengers, luggage, staff and stores. The train was crammed from end to end with passengers, and the vans were densely packed with baggage. On arrival at Euston, the train extended some distance outside the end of the long up platform. It will be remembered that, on starting southward from Rugby, the line rises constantly at 1 in 364 to the famous Kilsby tunnel. This is a somewhat severe pull at starting with so heavy a load, and not only in former times, but even quite lately, I have known a train, when hauled by one of the three-cylinder or four-cylinder compounds, assisted in the rear at the start by a shunting engine. In the present case, however, the converted compound Alfred the Great moved ahead without difficulty, and ascended the bank at a steadily increasing speed. The first mile was covered in a little over 3 minutes, the next two in 3 min. 39 sec. Before the Kilsby Tunnel was entered a speed of 40 miles an hour had been attained, and was still tending to rise. Welton, the first station from Rugby, was passed in 12 min. 6 sec., distance 7¼ miles, and the 5¾ miles thence to Weedon occupied 5 min. 37 sec., the pace on emergence from the tunnel rapidly increasing until it reached 70 miles an hour, which then was steadily maintained to the beginning of the 7-mile rise approaching Roade, the last three miles of which is at 1 in 326, and which brought our speed down to 52·8 miles an hour. Then came another rapid descent to the level stretch at the Castlethorpe water troughs and Wolverton, after which there is an almost continuous ascent for 20 miles to Tring, the last six miles being at 1 in 330. Our time for the 35¾ miles from Rugby to Bletchley was exactly 41½ minutes, and the ascent for the 15¼ miles thence to Tring took 17 min. 58 sec. The speed, which was 52·8 miles an hour at Bletchley, had increased to 54·2 miles an hour at Leighton, beyond which a short easier bit raised it to 56·3. Then came the last stretch of 1 in 330, on which the speed fell successively to 53, 50, and, finally, to 47·4 miles an hour. At this point, however, it persistently kept, mile after mile, to the summit. Such a performance with one engine and with so huge a load I have never before recorded in all my experience. The remainder of the journey calls for relatively little notice. Once over the Tring summit a continuance of high speed was easily maintained down the moderately falling gradient to Willesden. The time from Tring to the Willesden platform, distance 26¼ miles, was 25 min. 19 sec. The downhill speed, as a rule, did not vary more widely than from 65 to 70 miles an hour. The latter was reached at four different points, namely, near Weedon, Langley, Watford, and Sudbury respectively. The absolute maximum was 71·4 down 1 in 406. Such speeds are, of course, not at all exceptional on the Tring—Willesden length, which is peculiarly well adapted to swift running, and stress is only laid upon the fact of its attainment because it was rarely achieved by the compounds with their original valve gear, even when hauling loads of less than 200 or even 150 tons, owing to that tendency to sluggishness of action which Mr. Whale's alteration appears to have so effectually corrected. The entire time taken from the absolute start at Rugby to the dead stop at Willesden was 85 min. 42 sec.; the time between the Rugby and Willesden platforms was 84 min. 40 sec.; that is to say, the engine gained 4 min. 18 sec. at a 51¼ miles an hour timing, with a load of 485 tons behind her tender, and averaged 54 miles an hour from start to stop—54·6 from platform to platform. Whatever may be the future of these engines as altered, nothing can possibly get rid of the fact that such a feat was accomplished, and it certainly seems to me that I am justified in asserting, if on the basis of this one performance alone, that the alteration made in that locomotive type by the new chief mechanical engineer has converted it into one of the most useful and powerful in the kingdom, and will, if applied to the whole eighty locomotives belonging to the two different classes of the type, at least double the efficiency of the whole number. I do not mean that it will necessarily double their theoretical power, or even the actual power that they may be able to exert in certain circumstances. Possibly when running in full gear they might be able to haul as heavy a train at a slow speed as with the new gear. But this is not what they were built for. They were designed to run the heaviest North-Western passenger trains, and also to run them at the highest booked express speed, with their steam adequately expanded. That is what the "Alfreds" failed to do with their original valve gear, but appear well able to accomplish as now altered.

* No. II. appeared November 25th.

* See, f r details, THE ENGINEER, January 8th, 1904.

DESIGN OF HIGH-SPEED ENCLOSED STEAM ENGINES.

No. IV.*

A COMMON type of throttle valve is that shown in Fig. 22. This consists of a double piston working in a box, truly turned to receive it. As the steam enters the inside of the valve and escapes from the two edges, the valve is in equilibrium as nearly as possible; the only disturbing effect being that due to the very slight difference in diameter of the top and the bottom portion of the valve, which must exist for practical reasons. The valve is also unbalanced to the extent of the area of the spindle,

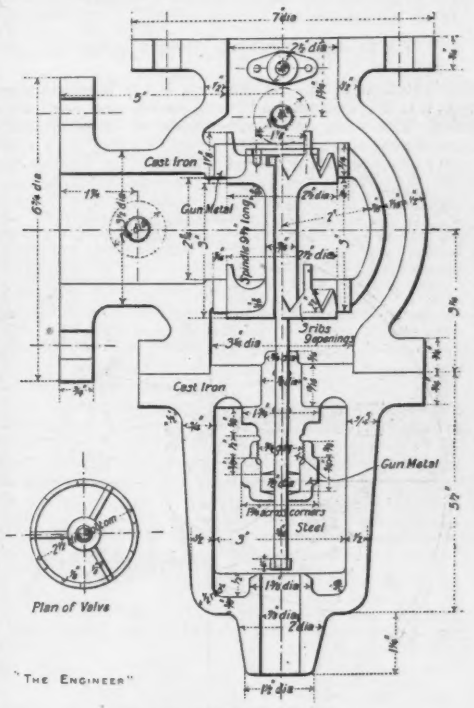


Fig. 22—THROTTLE VALVE

the pressure always tending to open the valve in the design shown.

This valve answers well for low pressures, but is very unsatisfactory, and, in fact, not at all suitable for high-pressure steam, and particularly when superheated. With high temperatures the valve-box does not retain its true form, and, consequently, if the valve is to work freely, it has to be made an easy fit, and so leaks. If an engine is directly coupled to a machine, very little steam is required to run it full speed at light or no loads, espe-

* No. III. appeared November 18th.

cially when condensing, and if the valve is leaky, it is almost impossible to hold the engine condensing with no load.

A great improvement on these valves is that shown in Fig. 23. This is simply a plain piston, working in a loose casing or liner. The object of this design is to arrange both valve and case in simple cylindrical form, so

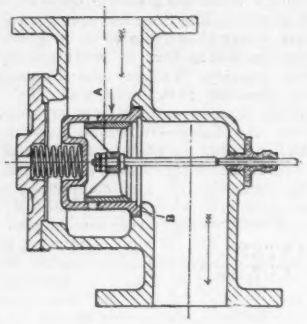


Fig. 23—IMPROVED THROTTLE VALVE

that when in position they are free to expand and keep their true form, without being distorted by the unequal expansion of the box containing them.

The casing A is truly circular, and can be machined all over, and is only held in position by the spring shown above the casing, the joint being made at

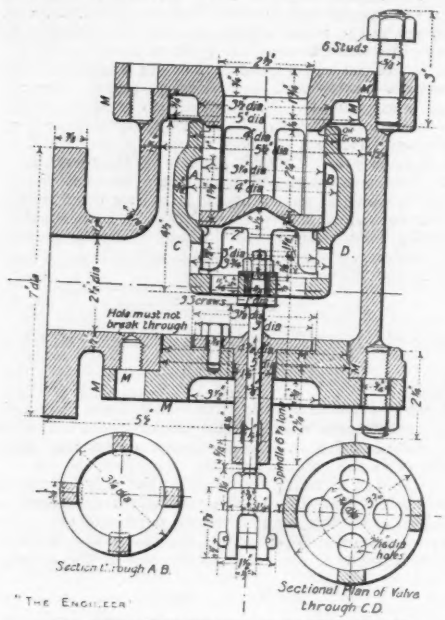


Fig. 24—DOUBLE-SEATED THROTTLE VALVE

the bottom edge B. As the cage is not bound in any way, it is free to expand all round evenly and keep circular. The valve or piston consists of a plain solid floating ring, also machined all over. As the valve and cage expand almost an equal amount, it is possible to make the piston a good fit in the cage and yet to be free

of the well-known type, but is designed so as to be of uniform section, and so that it can be machined all over, no ribs whatever being cast with it.

The valve box is quite plain, and the seat is fitted from the top side and secured in place by the same studs that

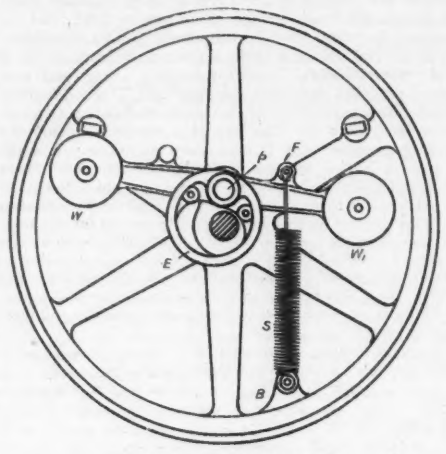


Fig. 25—BEGTRUP GOVERNOR

are used for the inlet pipe flange. The seat is thus not affected by the expansion of the box, and retains its circular form. The valve is cylindrical and of uniform section, machined all over, and the spindle being attached to the valve in the manner shown, leaves it free to centre itself without binding. Both valve and seat are made of cast iron. The spindle, which is very small in diameter,

is always advisable to provide a suitable means of adjusting the length of the spindle or rod connecting it to the governor; this is often required when first erecting the gear, and is very convenient for adjustment afterwards.

As will be seen, this valve can be adjusted after wear has taken place, and the seats can be skimmed up with ease if required. There are hundreds of engines working with these valves, and giving entire satisfaction.

Some most remarkable results in governing have been obtained with plain centrifugal governors combined with a throttle valve, similar to the one just described.

The variable expansion governor is not quite so simple. As generally arranged, this governor has to actuate the valve gear completely. It has thus to have sufficient power to drive the valve or valves, and at the same time be capable of altering the travel, and so the cut-off, to suit the variation in the load on the engine.

There are many powerful governors of this class in use for medium-speed engines, but very few have been fitted with success to high-speed engines; in fact, owing to the great difficulty of making a truly satisfactory governor of this class, very few firms offer to sell high speed engines with variable expansion governors. In many designs adopted the stresses in the governor itself are sufficient to prevent it being at all sensitive to a change in speed. This causes great wear, and very often sluggish governing. Some of the governors in use are very powerful as regards inertia effect, but very weak centrifugally, and consequently are suitable for sudden changes of load, but are very unsatisfactory when the load varies gradually. Some governors have been so arranged that their inertia effect is contrary to the weight's centrifugal force when a sudden change takes place. This is not an advisable arrangement. It might be asked that, as such excellent results are obtained with throttle governors, which have no inertia effect, why should variable expansion governors require it? To this there is only one answer, which is that in the case of the variable expansion governor, a very great weight of

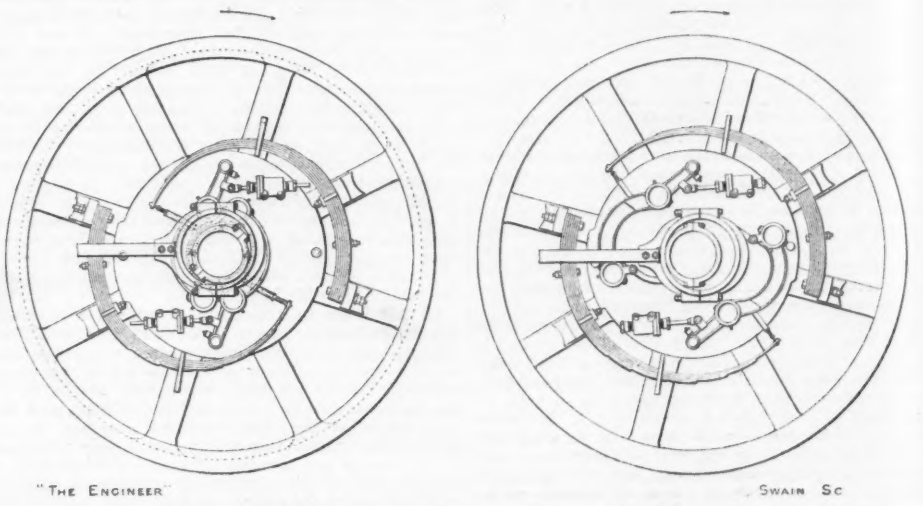


Fig. 26—McINTOSH, SEYMOUR AND CO.'S GOVERNOR

is of steel, and works through a long bush of gun-metal or phosphor bronze, which does away with the necessity for a gland. This is a good feature, as a gland is objectionable here, where a little friction may cause the governor to hunt, and it is so easy for a careless man to lock the spindle by screwing up a gland out of square. The cavity round the spindle at the lower portion of the

parts has to be moved when the governor has to act, whereas in the throttle class there is simply a light throttle valve to move. Successful governors of this class are mostly patented designs, and not quite common property. Among the best known are the "Begtrup" and the "Browett-Lindley;" the latter was fully illustrated and described in our issue of May 27th, 1904,

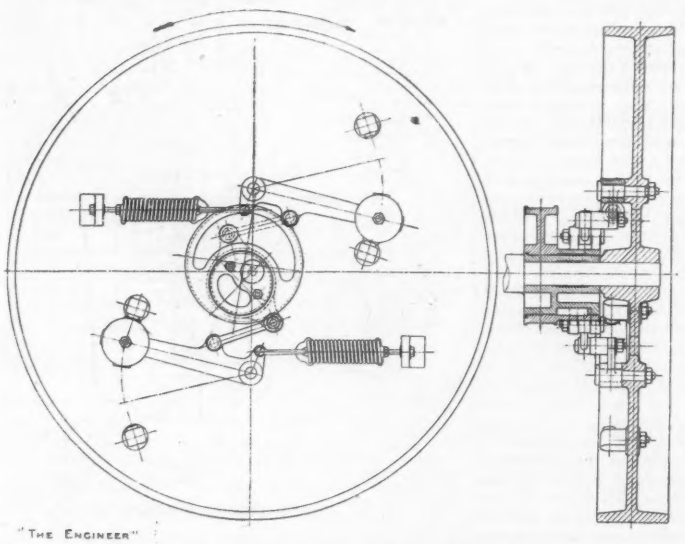


Fig. 27—VARIABLE EXPANSION GOVERNOR

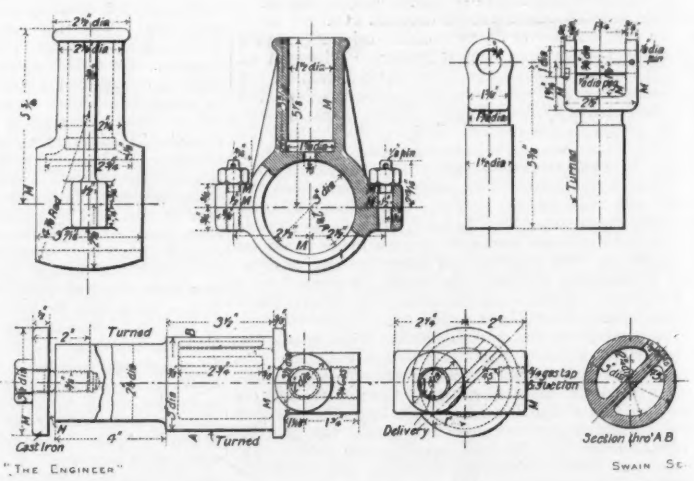


Fig. 28—VALVELESS OIL PUMP

under very varying pressures and temperatures; but there is one objection, and that is there is no means of adjusting the valve when worn. On this account, the seated valve has become more popular.

There are many designs of double-seated throttle valves in use, all possessing some special detail in design. but as illustrating one of the latest satisfactory types Fig. 24 is given. This valve is only a double-beat valve

bush is to collect any water which leaks past the fitting portion above; this can then be connected up to a small drain pipe and led away. It will be noticed that the bush is not forced into the casting, as is often done, but simply centred at the top end and left free for the rest of its length. If the bush fits the casting for the whole of its length, it cannot be made as good a fit on the spindle without binding when working at high temperatures. It

whereas the former, a type which is very largely used in America for medium-speed engines, is shown diagrammatically in Fig. 25. This governor, as can be seen, is weak centrifugally, but very powerful as regards its inertia effect; also practically the whole centrifugal effect of the weights and bar has to be borne by the pin at P, and the valve gear has a disturbing effect upon the governor, the excentric being free to oscillate upon the

pin P, along with the bar to which it is attached or formed with. A little extra friction in the valve gear can thus immediately affect the speed and upset the governing.

An excellent governor of the type under consideration is that shown in Fig. 26, as made by Messrs. McIntosh, Seymour and Co., of New York. This governor is very powerful centrifugally and extremely sensitive.

The position of the governor parts when the engine is not running is shown above at the left. The centrifugal weights are at their inner limit of travel, and the governor excentric is so placed as to give maximum cut-off. In the view at the right the centrifugal weights have moved into their extreme outer position, and at the same time have pulled ahead the excentric, to which they are connected by links, and which is free to revolve on the shaft, sufficiently to cut off the steam entirely from entering the cylinder. This condition is approached when the engine

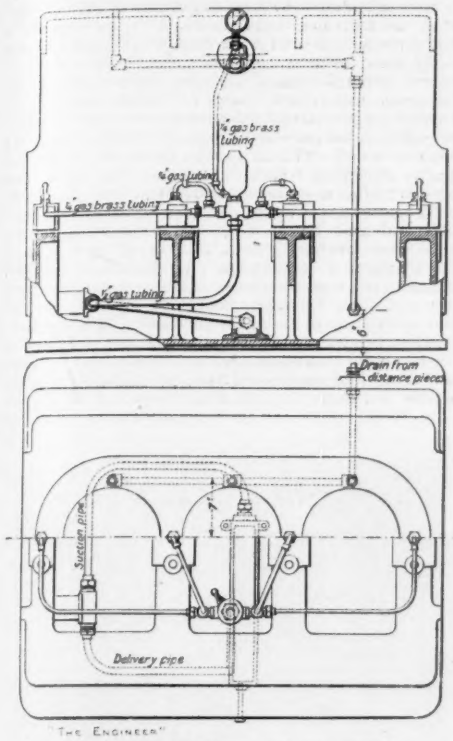


Fig. 29—ARRANGEMENT OF OIL PIPES

is running and the load is thrown off. The centrifugal force of each weight is opposed in a direct and practically frictionless manner by a plate spring through a hardened steel pin with a ball-and-socket bearing at the end of the spring, and at the centre of gravity of the weight, so that there is no friction or pressure due to this force upon the pin upon which the weight swings. This permits the use of a very heavy weight, having great centrifugal force and making the governor powerful. The pins are made of tool steel, hardened and ground, turning in bushes of phosphor bronze. There are provisions for grease lubrication of all wearing surfaces. The tension pins between springs and centrifugal weights are arranged to telescope, in order that they can be adjusted to secure proper sensitiveness, for by lengthening these pins the governor can be made to regulate more closely, and by shortening them over-sensitiveness or racing can be removed. Dashpots are provided, which give stability to the governor, so

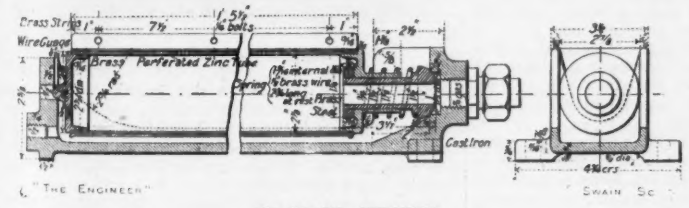


Fig. 30—OIL STRAINER

that it can be adjusted to give nearly perfect regulation without any tendency to race under a fluctuating load.

The speed at which the engine is to run can be raised or lowered by reducing or increasing respectively the small lead weights provided for that purpose in holes in the centrifugal weights. This adjustment can be made last, for it does not alter the sensitiveness of the governor to change the speed in this way, while any adjustment of the sensitiveness, as described above, also changes the speed.

The governors of McIntosh and Seymour engines, when designed for driving alternating-current generators in parallel, are provided with patent compound time-delayed dashpots, without which successful parallel operation is impossible with generators of large size and high frequency. When two alternating-current generators are running in parallel, each generator has a tendency to oscillate back and forth with reference to the other, with periodic transfer of load from one generator to the other, called "surging." A governor which is properly sensitive, without the time-delay dashpot, must respond to these fluctuations of speed, and when the conditions are such as exist with large generators of high frequency, resonance is produced—that is, the action of the governor tends to increase the speed fluctuations, causing the surging to build up from an imperceptible beginning until parallel running is impossible. If the governor is damped by ordinary devices sufficiently to stop this effect, it will fail to control the speed properly, with danger of the engine running away if a considerable part of the load is suddenly thrown off. The compound time-delay dashpots damp heavily the governor action for any fluctuations of speed of very short duration, such as those just described, but under the action of even the slightest change of speed, if persistent beyond this short interval of time, automatic release of the governor takes place, avoiding any impairment whatever of the speed regulation.

An electric speed changer, also patented, enables the speed of an engine designed for this service to be raised or lowered four or five revolutions from the station switchboard while the engine is running, so that it can be quickly and conveniently synchronised when starting in parallel with other units already in operation, or so that the engine can be made at any time to carry any proportion desired of the entire station load within its maximum capacity. Hence it can readily be seen that speed changes add to the convenience, economy, and flexibility of operation in power plants consisting of alternating-current generators.

The mechanism of the speed changer consists of an auxiliary weight arranged to slide on the main centrifugal governor weight while the engine is running, in such a way as to change the speed of the engine by altering the centrifugal force to be resisted by the governor spring. The auxiliary weight is moved by a screw, which in turn is rotated by a small electric motor mounted on the governor weight.

This motor can be connected electrically, through a collector on the engine shaft to a double-throw starting switch on the station switchboard, in such a manner that the amount and direction of the motion of the electric motor can be controlled by the starting switch, so as to give the desired change of speed.

A very serviceable type of governor is that illustrated in Fig. 27. This governor can be designed to be very powerful centrifugally, and if placed under forced lubrication and suitably enclosed, will give results equal to all that is generally required in the way of governing. The main excentric, as will be seen from the illustration, is mounted upon an inner one, this taking all the thrust of the valve gear. Owing to this, the friction of the valve gear has very little disturbing effect upon the governor; in fact, it is possible to govern an engine with unbalanced flat slide valves with this class of governor, but this is not to be recommended.

As is the case with the throttle type of governors, no matter how good the governing mechanism is, unless the valve is steam-tight the governing will be unsatisfactory. This is a very important detail with the variable expansion type, as the wear on the valve is considerably more than on a throttle valve. Piston or balanced slide valves are the most suitable type, and it is only necessary to alter the cut-off of the high-pressure cylinder, even with a triple-expansion engine. This gives the governor quite sufficient to do, and is satisfactory in practice. Owing to the effect of a little leakage upon the governor at light loads, it is often advisable to adopt an adjustable type of piston valve similar to that illustrated in Fig. 7 or 8 for the high-pressure cylinder. In the case of the throttle governor, even when the high-pressure valve is slightly worn, it does not affect the governing, as this is under control of the throttle valve.

Lubrication.—The question of lubrication with high-speed engines is most important, and the introduction of the system of forced lubrication has, no doubt, had more effect upon the success of the double-acting high-speed engine than any other detail in connection with the machine.

As the arrangements of this system were fully illustrated and described in these pages recently—see April 29th—it is not necessary to illustrate them here, beyond showing one typical arrangement—see Fig. 29—and as the valveless oil pump is perhaps the most important detail in the system, a working drawing of one suitable for small engines is given in Fig. 28. The design holds good even for the largest sizes.

The pump shown is driven from one of the excentrics for working the valve gear. This is a very convenient method of driving, as it gives a good angle of oscillation to the pump barrel, which is necessary to get sufficient port opening, and it also saves an extra excentric. The barrel is made in two pieces, being provided with a loose cap where it fits on the trunnion. This allows of adjustment when required, but if made a good fit to commence with, these pumps require very little adjustment, as, owing to the fact that they work in oil and pump oil, and the wearing surfaces are very large, the wear is infinitesimal.

The trunnion is shown arranged for securing to the side of the engine base, and where this arrangement can be followed it is a saving, as it dispenses with a loose bracket for carrying it.

A trustworthy oil filter should always be fitted to the suction side of the pump, and should be so arranged that in can easily be removed for cleaning. Although these engines are enclosed, it is surprising the amount of grit which is separated from the oil of a high-speed engine, and the filters require to be cleaned regularly. A handy design of filter or strainer is illustrated in Fig. 30. This is designed for placing on the bottom of the engine base, as shown in the arrangement drawing Fig. 29. The strainer consists of a perforated iron tube covered with fine copper gauze, which is folded round the tube and clipped together by small nuts as shown, strips of brass being soldered on to the gauze at the edges for that purpose. The strainer itself is carried in a cast iron cage or trough, which is bolted to the base and is held in position by the spring shown, which presses outwards the mouthpiece against the seat prepared to receive it in the trough. The other end has a projecting knob, which engages with a recess in the trough as shown. To remove the strainer it is only necessary to get hold of the tube and force it towards the suction end to compress the spring, and so relieve the knob end, when it can at once be drawn out and cleaned. When putting into position again it automatically locks itself. The suction pipe from the pump is coupled up to the strainer trough as shown. The depth of oil in the base should be sufficient to cover the strainer entirely, and the strainer should be about an inch or two from the bottom of the base, so that any water which collects will not be drawn into the pump, and may be run off even when the engine is at work.

THE INTERNATIONAL ENGINEERING CONGRESS AT ST. LOUIS.

No. V.*

HIGHWAY CONSTRUCTION.

M. FORESTIER, Inspecteur Général des Ponts et Chausses, in a short paper reviewed the practice in France, under Government direction. In planning roads, the engineer has to consider the demands of those who desire speed and comfort, as well as of those who desire the heaviest loads that horses can haul. For maintenance, up to 1775, the peasants once a year brought stones from the fields to the roads, where they were broken and the loose bed of stone left to carry the traffic. But Trezaquet gave the work to contractors, on condition that a man should be employed to care for a certain length of road. These labourers are now, however, paid by the road administration. The use of automobiles is destructive, as the rubber tires pull up the small stones, and "after an automobile race the best road will look very much like a garden path after it has been scraped and raked." The only remedy suggested to prevent this action, and the consequent unpleasant dust, is swabbing with hot pitch, which is at best a makeshift. Mr. James Owen gave a paper dealing with conditions and practice in the United States, discussing them particularly in regard to topography, geology and climate. He much preferred the Telford to the Macadam construction, as the result of his own experience, but described also the methods of construction of gravel roads, sand clay roads, &c., in districts where no stone is available at reasonable cost. Such roads, when designed and built under engineering direction, are both economical and satisfactory.

Mr. R. J. Thomas, of England, referred to the serious trouble caused by the suction of pneumatic tires on the wheels of automobiles, which pulls the road to pieces in an astonishing manner. Only the strongest construction and smoothest surface will resist this action, although he had found a partial remedy in the use of a coating of tar on the road.

NAVAL ARCHITECTURE.

Sir William H. White, President of the Institution of Civil Engineers, and late Director of Naval Construction, read a paper summarising the development of naval architecture in Great Britain during the last ten years. We need not discuss the review of British warship building in 1894. French naval authorities led the way in regard to the use of water-tube boilers, but since 1896 there has been universal use of such boilers in the Royal Navy.

As experience has been gained and the relative merits of competing types of boilers has been practically determined, the difficulties have been overcome. The great advantages obtainable with water-tube boilers have been confirmed, and their comparatively inferior economy in coal consumption has been remedied. The Admiralty Boiler Committee in preliminary reports—1903—advised the use of a combination of tank and water-tube boilers in order to secure greater economy in coal when cruising at low speeds. In the writer's address in November, 1903, at the Institution of Civil Engineers, he stated that this system was carefully considered in designing the "Powerful" class, and was set aside in favour of a complete installation of water-tube boilers. Further, he ventured the opinion that the Boiler Committee would eventually reach the same conclusion. It is interesting to note that this anticipation has already been realised, and that for the latest designs the Committee has recommended the exclusive adoption of water-tube boilers for his Majesty's ships. As yet the determination of the best types for use is still incomplete.

Very considerable developments in torpedo-boat destroyers have been made. The introduction of the steam turbine was made concurrently with a remarkable development in the use of the express type of engine in destroyers and small cruisers, but the advantages of the rotary type were so great that there could be no doubt of the ultimate result, especially in merchant vessels which are constantly working at or about the maximum engine power. At full power the turbines have their greatest efficiency and excel the best reciprocating engines in economy of steam, but their relative economy decreases with the power, and at low powers they are inferior to the engines.

The merchant shipbuilding for the beginning and end of the decade was as follows, and the maximum was in 1899:—

	Steam.		Total (steam and sail).	
	No.	Gross tons.	No.	Gross tons.
1894	346 ...	663,396	414 ...	725,208
1899	568 ...	1,382,289	597 ...	1,385,715
1904	358 ...	973,511	398 ...	988,664

The paper gave a very interesting review of the development of transatlantic liners, and also of special classes of cargo steamers, oil tank steamers, meat carriers, ore carriers, cable-laying steamers, turret type and single-deck steamers. Since 1894 there have been many improvements in the propelling apparatus, tending to economies in weight and coal consumption. In internal combustion engines, Thornycroft's have designed machinery of 6000 horse-power for a torpedo-boat destroyer, and the Vickers and Daimler firms have built

* No. IV appeared December 2nd.

engines up to 800 horse-power. While oil fuel can be used to advantage, the practical difficulty is that of adequate supplies at reasonable prices. The use of experiments with models in tanks are now much more common and have produced most important results in regard to form of hull and propellers. Without such experiments it would have been impossible to proceed with any confidence in the design of the new 24½-knot Cunard steamers, owing to the novel problems arising from the use of four shafts and propellers driven by steam turbines.

Sir Wm. White pointed out that the instruments used by Japanese naval engineers to record the vibrations in warships due to the running of the engines are a practical application of their delicate seismographic or earthquake-recording instruments.

MARINE ENGINEERING.

A long paper by Mr. W. F. Durand related principally to the boiler and machinery equipment of steamships. Mechanical stokers have not proved satisfactory as yet, but there is a field for the mechanical handling of coal from the bunkers to the furnace. The efficiency of the use of the hot assisted draught has been proved; the closed fire-room system is rarely used, except on naval vessels, and in open fire-room systems the induced draught gives the better results, although the plant is bulkier and heavier than that for the forced draught with closed furnace front. The use of oil fuel was discussed in considerable detail, and its extension was predicted. Water-tube boilers now occupy the field in naval practice, owing to their advantages, but in marine practice the advantages are in favour of the Scotch or tank boiler. Two large passenger steamers on the Great Lakes, however, have Niclausse boilers of 10,000 horse-power for each ship. Aside from the introduction of the steam turbine there has been little essential change in the marine engine during the decade. The typical engine is still the triple-expansion, with a high and low-pressure cylinder ratio of 1 to 6¼ or 7, and steam of about 180 lb., giving a total expansion ratio—allowing for high-pressure clearance—of 10 or 11. The reason for the relatively slow advance of the quadruple-expansion engine is that the gain over the triple is slight, while for the same power it is heavier, has more parts, and is more expensive. A significant feature in relation to economy is the development of the use of superheated steam; the best results may be expected with moderate steam pressure and high superheat, rather than with high pressure and less superheat.

ORDNANCE.

Three important papers were prepared by officers of the Ordnance Department of the United States Army. Captain O. C. Horney's paper dealt with gun construction, including improvements in steel and in powder, and describing the Woodridge, Brown, and Crozier wire-wrapped guns, which have been tried by the Department. Captain E. P. O'Hern's paper described sea coast gun-carriage design and construction, including several styles of disappearing carriages. The use of mortars placed in concealed pits was also mentioned, and the computation of stresses for the design of gun-carriages was also dealt with. The third paper, by Captain T. T. Ames, was on the question of ammunition, relating particularly to smokeless powder. The Navy Department has adopted a nitro-cellulose powder, and has a large plant for its manufacture. This was later adopted for the army, as the nitro-glycerine powder formerly used gave irregular and high pressures.

FORTIFICATIONS.

This branch of engineering was the subject of a paper by Major G. W. Goethals, United States Engineers. This was interesting and valuable, but—like the ordnance papers—cannot be abstracted with advantage. One special point, however, relates to a proposal made a few years ago to reduce the cost of emplacements by substituting vertical iron rails for concrete in the parapet. In a test, however, a concrete parapet sustained three shots with little injury, while a single shot at the rail parapet smashed the rails to pieces, scattering the fragments and hurling them high in the air. Major Goethals made the following remarks respecting the coast defences of the United States:—

> Coast defence vessels form an important part of a complete system of defence, but, as yet, no steps have been taken in the United States for procuring such vessels, if the monitors belonging to the navy are omitted from consideration. The same is equally applicable to torpedoes and submarine boats, although the Torpedo Board has recommended the purchase of a certain number of submarine boats for experimental purposes. The question of land defence is a very important one, and the necessary plans have been prepared by the local engineer officers for giving proper protection to the defences against any attempt which may be made against them by landing parties, and, in the event of war, it is expected that the necessary steps will be undertaken for their construction, using the field type of fortification.
>
> Congress for the past ten years has been more liberal in its appropriations for coast defence, and, as a result, the heavy guns which are to be mounted under the approved projects are, to a great extent, already installed; and, in this respect, the coast is in a fair state of protection against attack. But these appropriations are gradually falling off and, until another war scare, it is probable that comparatively little work will be done. At present the greatest difficulty is in the proper care of the guns already mounted. The Coast Artillery branch of the service, to which this belongs, is too small in numbers to man the guns now available, and the greatest danger now confronting the United States arises from this deficiency of properly trained men to fight the guns.

SURVEYING.

Two papers were presented in this section, prepared jointly by a number of officers of the United States Coast and Geodetic Survey, describing the instruments, methods, and work. The work of precise levelling in the United States is now done at a total cost of £1 8s. 4d. to £2 4s. 2d. per mile, including all salaries and the cost of bench marks. In the new levelling instrument for this work, the telescope cannot be reversed end for end or rotated on its axis. The largest correction necessary to apply to any line run with this instrument is 0·00039ft. per mile, while on more than half the lines the necessary correction to close all circuits is 0·00010ft. per mile. About 19,800 miles of precise levelling have been done. Great improvements have been made in the rapidity of base measurements. The topographic and hydrographic work, boundary surveys of public lands, and methods of gauging the flow of streams were all discussed, the papers describing the work and methods of the Survey, and the improvements effected during the past decade.

MINING ENGINEERING.

A review of the operation of mines in France was given by M. Gruner, secretary of the Central Committee of Collieries. The Poetsch freezing process and the Portier-Saclier grouting process for solidifying quicksand were mentioned, also the development of safety appliances and hygiene in lighting and ventilation. For mines not entirely free from firedamp, compressed air instead of electric traction was advocated.

ENGINEERING EDUCATION.

This important subject was treated at some length in a paper by Professor Robert Fletcher, of Dartmouth College. After a review of the history and development of engineers, engineering, and engineering education in the United States, he discussed particularly the development during the last decade. Nearly every State has a "college of agriculture and mechanic arts," under some form or name, but although there are courses in agriculture, the graduates usually enter some line of engineering practice or manufacturing industry. The *pros* and *cons* of "correspondence schools" were discussed, and their value for engineering training would seem to be limited. As to specialised instruction, some believe in a general training in fundamental subjects, and these those which determine engineering practice in general, without giving much time to details; others believe in the student studying with reference to some specialty even in the secondary schools. But "it is found in practice that one well trained in the fundamentals seldom fails to fit himself—given a little time—to a special responsibility." Some large corporations which control many lines of industry have successfully adopted the policy of taking young men, preferably technical graduates, into their shops and offices, for one to three years, of special training and instruction in particular branches. There should be an endeavour to select the student material at entrance so as to exclude the unfit and unworthy; the incapable should be weeded out in the process of training, and the tests at graduation should be so impartially applied that the testimonial of the institution would everywhere command confidence.

THE MEASUREMENT OF RUNNING WATER IN RIVERS AND OPEN CHANNELS.

By W. H. Wheeler, M. Inst. C.E.

Very much greater importance is attached to the value of water by the United States Government than is the case in this country.

In one of the reports issued by the Water Supply and Irrigation Department of the Geological Survey of the United States it is stated that the wealth of America is due, in a large measure, to the great natural resources of the country, and to the use made of these by the inhabitants. Water is regarded as one of the chief of these. The rivers that pass through some of the States, with their huge discharge and water power, have been in the past, and will continue to be in the future, a perpetual source of wealth.

The history of the States' progress is largely a history of the development of their water resources. It is further stated that there never was a decade in the history of the country when the development of water power has made such strides as during the last ten years, when even the Falls of Niagara have been harnessed for the benefit of man. In the Eastern States; in the Central, North-West, and on the Pacific Slope, there are water powers of great size and value, many of which form the basis of the industrial life of large communities.

In the broad, flat plains west of the Mississippi, where the rivers lack the fall required for power development, large areas of land depend almost entirely on irrigation for their cultivation, and, without water, industrial life in these regions would be impossible.

During the ten years 1890 to 1900, the use of water power has increased 30 per cent., and the power now in use is estimated at about 1¾ million horse-power, that which might be utilised by the rivers in America being equal to 200 million horse-power.

The value of water for the supply of towns and domestic use is almost incalculable; and with the rapid increase in the population becomes daily of increasing value. In most parts of the country the public water supply of the cities and towns is derived from the rivers, and large sums are spent in conducting water from the streams to the centres of population.

For want of proper information too often great hydraulic works, both for domestic supply and power purposes, have resulted in great financial loss.

To afford information upon which to base estimates of the available water supply, the Hydraulic Department of the United States Geological Survey has for several years been collecting data in regard to the flow of the rivers of the United States, and their variation from season to season. As the survey and current observations for each river basin is completed, a report, containing the result of the survey, is published. Upwards of 90 reports, bearing on water supply, have already been issued.*

The great majority of these reports relate to the results obtained in the various rivers and drainage basins surveyed, but there are also separate papers on such subjects as the relation of rainfall to the run off from the gathering ground; the motion of underground water; the records of large floods; and on wells and pumping machinery for irrigation purposes.

A large staff of engineers and assistants is engaged in this and the irrigation works for reclaiming the arid lands of the west. For the use of these observers, and to secure uniformity of practice, about twelve years ago a report was specially devoted to stream measurements and the methods and instruments used in carrying them out. Recently a new edition, brought up to date, has been issued, which also embodies the results of an extension of the investigations in the hydraulic laboratory of Cornell University.†

It is extremely difficult, if not impossible, to obtain really accurate measurements of the quantity of water passing down a channel having an irregular bed and frequent curves in its course. This is due to the constant changes in the velocity, not only as between the surface and the bottom and between the sides and the centre of the stream, but owing to the eddies caused by irregularities in the bed and sides of the stream, the velocity varies at almost every point and from instant to instant. When closely observed the water passing along an open earthen channel is seen to swirl, forming innumerable small whirlpools, and where there are solid particles in suspension it will be observed that these have a constant rotary action, both in a horizontal and vertical plane. It is due to this upward rotary action that solid matter, the specific gravity of which is nearly double that of the water, is carried along in suspension, and does not subside to the bottom of the stream.

The author of the report referred to states that several of the observers engaged on the survey have noticed that all water in motion has an intermittent velocity, increasing and decreasing according to some undiscovered law; and these pulsations hold good in streams of all sizes, from those of moderate dimensions to such rivers as the St. Lawrence. These variations have an important bearing on the kind of instrument best suited to measure the velocity, as some—the float, for example—give the velocity of a single impulse; while others—as the current meter, if allowed to run for a sufficient time—show the

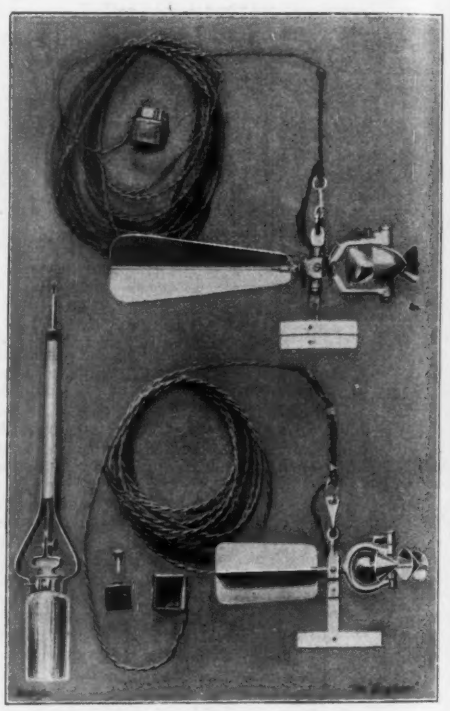


Fig. 1—CURRENT METERS

average velocity due to all the impulses during the observation.

Harlacher's observations in German rivers showed that the motion of the particles of water in a stream varied 20 per cent. at the surface and 50 per cent. in the bed velocity in a few seconds.

Observations made by Professor Baum in the Rhine showed a continual change in the velocity for a constant depth, the records being obtained with a current meter, recording the time of each 100 revolutions over a period of two hours.

Professor Unwin—"Minutes of Proceedings," Institution of Civil Engineers, vol. lxxii.—records observations made by him in the Thames. He also noted the time of each 100 revolutions, and upon plotting the time and the revolutions, found that they gave a very irregular curve. The mean of each 500 revolutions, however, when plotted with the corresponding time, approached very nearly to a straight line. These observations were made in a tidal stream, and carried over both the flood and ebb tide, the maximum depth being 23ft. The meter was held at 1·5ft. below the surface and 0·82ft. above the bottom and at mid depth.

In 1899 Mr. L. C. Sabin, one of the engineers of the American Geologic Survey, made some experiments in the St. Clair River to determine the pulsation and fluctuation in the velocity of the water. Four meters were used, placed 50ft. apart and at the same depth. In the first series of observations the meters were placed in a line across the river at right angles to the current. Simultaneous readings of the four meters were taken every

* "Water Supply and Irrigation Papers," United States Geological Survey, Washington.

† "Accuracy of Stream Measurements." By E. C. Murphy. Second edition. "Water Supply and Irrigation Papers," No. 95. United States Geological Survey, Washington. 1904.

fifteen seconds for periods of ten minutes each. The observations, when plotted, showed curves with two sets of waves, small ones of fifteen to sixty seconds, and larger ones of three to six or even more minutes' amplitude. The motion of water in natural channels is therefore exceedingly complex, and very different from the uniform flow in parallel straight lines that is assumed in deriving the common hydraulic formula.

The velocity will vary as much as 45 per cent. A velocity measurement of 100 revolutions 1½ft. below the surface may be in error 8 per cent., and one at 20ft. 37 per cent. These fluctuations have a duration for the smaller class of thirty to sixty seconds, and the larger ones from five to ten minutes.

The conclusion to be arrived at is that velocity observations of short duration are of little value unless they are well distributed over the discharge area; and that, in order to eliminate the effect of pulsation, each observation should extend over a period of from six to ten minutes.

It may be taken, then, that all estimates of the quantity of water flowing in rivers and similar open channels are only approximations, but that where the observations are carefully conducted they will have a result sufficiently accurate for all practical purposes.

Two methods are generally in use for measuring the velocity of running water in open channels, one by floats of various kinds and the other by current meters.

By the first method the mean velocity of a comparatively few particles of water is found for the time required for the float to move between the sections of observation—that is, the float is acted upon by the particles about it during the time it is passing over the measured distance. It is carried by a single impulse of the water, and is not affected by the succeeding impulses, which may be greater or less than the particular impulse that moves it. The mean velocity being found for only a given distance, it is necessary to obtain the mean sectional area over the whole of the distance, and this requires the measurement of many cross sections. Also where the bottom is very irregular, as in large streams, it is not possible to devise a float that will be acted upon by the deep places without trailing over the shoals. In a wide stream, also, it is difficult to regulate the course of the floats and obtain observations of the middle and side currents, and assistants are required to fix the position of the float-path by angular measurements, and as repeated observations are required to obtain accurate results considerable time is occupied. Captain Cunningham, in his experiments on the Ganges Canal, placed the standard number of observations at forty-eight, which occupied several hours. Although, therefore, it is claimed that floats as instruments of measurement are very inexpensive as compared with meters, considering the staff required to take the observations and the time occupied, they are in reality an expensive method of obtaining accurate stream measurements.

Two methods are adopted for recording the velocity by floats, one by taking only the surface velocity and reducing this to the mean by a determined coefficient, or by using a surface and sub-surface float, or by one that extends over the greater part of the depth.

Surface floats are so liable to be acted upon by wind that results obtained by this method cannot be relied on. The double float, consisting of a light surface float attached by a thin line or wire to one heavier than the water, give better results than mere surface floats, and have advantages in streams carrying floating weeds or grass, where the meter is apt to become clogged. When, however, a stream is encumbered with growing weeds, floats are apt to become entangled in these, and, even if not altogether stopped, do not give correct results.

The simplest, and, on the whole, most satisfactory form of floats are those composed of wooden rods, or hollow cylinders of copper or tin, made in lengths so as to be adjustable to the depth of water in the stream to be measured. The bottom rod is weighted with shot or lead so as to keep the float vertical. A small flag attached to a wire on the top rod, while serving to show the position of the float, is not sufficient to affect the motion of the rods by the wind. These floats receive the impulse of the varying velocities at all parts of the depth, and cause little disturbance.

Captain Cunningham, in the elaborate series of experiments which he made in the Ganges Canal, and which are fully reported in his paper in the "Minutes of Proceedings," Institution of Civil Engineers, for 1882, vol. 71, came to the conclusion, as the result of a great number of observations, and after making allowance for the known inaccuracies of the double float, that the velocity obtained by the rod float has a closer approximation to the mean velocity than the value deduced from double floats, and he gave preference to this method of measurement to that obtained with a current meter. The rods which he considered as giving the best results were 1in. tin tubes loaded at the bottom. These he found more simple to construct than double floats, more easily handled, and less delicate in work. The conditions he laid down as favourable to the use of these floats were a straight reach of stream of nearly uniform cross section, not less than 250ft. in length, with an average bed slope, regular banks and side slopes, and depth not exceeding 15ft.

In large rivers where there is much traffic, logs of wood, weighted with iron at the end and the top painted white, have been used. The timber floats used in the Thames for the purpose of determining the rate of travel downwards of the fresh water were octagonal in shape, 12¼ft. long, 11½in. diameter, and immersed 12ft.; the float used recently at Avonmouth consisted of a five-gallon oil drum, having a coloured disc at the top, to which was suspended a bushel basket weighted with stones.

Many of the difficulties and objections of floats are obviated by the use of the current meter. Only one cross section is required, and the time occupied is very considerably less than with floats.

The current meter, as originally constructed, had many drawbacks. The recording apparatus was thrown in and out of gear by a string, and it was necessary to lift the instrument to the surface to read the revolutions, and the sand and dirt in the water retarded the train of wheels. An electric recording device is, however, now used, by which the recording instrument is placed out of the water, either in a boat or on land, and it is not necessary to lift the meter to the surface to read the number of revolutions, which are recorded electrically, or may be counted from the indications of a buzzer—Fig. 1.

In small streams the meter is attached to a rod, but in larger rivers it is suspended by a cable, either from a boat or a bridge, or a cable stretched across the stream—Figs. 3 and 4. A sinker is attached to the under side of the meter, and when the current is strong the meter is suspended from the end of a pole which projects from the place of observation, and a light line is attached to the meter and brought to the land end of the projection, so as to keep the meter in a vertical position—Fig. 2. These illustrations show the methods adopted in the United States, and are taken from Mr. Murphy's report.

When the meter is held by a cable the reading is subject to some error owing to its swaying, but Professor Unwin has shown that this cannot amount to more than three per cent. of the result given. Observations made by Professor Unwin in the Thames were made with an Amsler-Laffon electric meter, suspended from a steam launch, moored fore and aft by a wire, with a sinker attached weighing 60 lb. A bell on the launch sounded at every 100 revolutions. The time required to obtain one complete observation was three minutes.

There are two methods of using a meter, one where the instrument is held at a certain point in the cross section for a stated period, usually 50 seconds, and the number of revolutions of its wheel during that time are observed on the dial or by counting the clicks of a buzzer. This is called the point measure. The other is the integration method, by which the meter is moved up and down several times in the same vertical at the sides and centre of the stream, or diagonally across from one side to the other at the same time that it is moved vertically.

The point method is considered by the American surveyors as the more accurate, if sufficient observations are taken in the section. In the point method the meter can be held at three-tenths from the surface, at mid-depth, and at the bottom to obtain the minimum average and minimum velocities; or at six-tenths of the depth for the average velocity. In the case, however, of canals and narrow natural channels, a point two-thirds below the surface should be taken to get the average.

Professor Unwin's observations on the tidal water of the Thames gave the mid-depth as varying from 0·93 to 0·98; of the observation it was 1·64ft. below the surface, and the bottom as 0·75 of the surface observation.

The accuracy of a discharge measurement depends largely on the accuracy of rating the meter used. Four methods are in use for rating meters. (1) By checking the results given by the meter by comparing them with those obtained by floats; (2) by moving the meter through still water with a known velocity; (3) by observing the velocity at many points in a cross section and comparing this with the known mean velocity; and (4) by attaching the instrument to a long arm and revolving it about a vertical axis in a body of still water. The second method is the one now universally used by the United States surveyors. The meter is suspended from a boat, and is moved with a uniform velocity through still water at a depth of two or more feet below the surface. The length of a run varies from 100ft. to 300ft., with a starting run sufficient to allow the meter wheel to reach the proper speed before entering the run.

It is sometimes required to measure the flow of water under a coating of ice. In this case the friction between the water and the ice retards the surface velocity. The observations are made by cutting holes in the ice large enough to admit a current meter. As the result of observations in the United States, it was found that the flow of water under such conditions is somewhat similar to its flow in pipes and in closed flumes. The mean velocity occurred at two points in the vertical, 0·11 and 0·71 of the depth; the maximum occurring at 0·36 of the depth; the mean velocity was found on the average to be 0·88 of the mid-depth. In all cases the measurements were taken from the underside of the ice. With broken ice having a rough surface, the point of maximum velocity was found to be at 0·55 of the depth, and lower than when the bottom of the ice was smooth, the surface velocity being less, and the bottom velocity greater.

Mr. Murphy's report also contains the particulars of a series of observations made on natural watercourses in the United States, with the view of comparing the different methods of taking velocities, so as to establish the point of mean velocity below the surface and the point at which the meter can be held, and the velocity in the vertical found by one observation.

As the result of these experiments the following conclusions were arrived at, it being assumed that the channel where the observations are made is approximately straight, regular in shape, with few obstructions, and the bed such that there are few projections more than 4in. in height above the general contour:—

(1) The distance of the thread of mean velocity below the surface increases with the depth and with the ratio of width to depth. In general it varies from 0·55 to 0·65 of the depth.

(2) In a broad shallow stream from 3in. to 12in. in depth, and having a sand or fine gravel bed, the thread of mean velocity is from 0·50 to 0·55 depth below the surface. The mean velocity in a vertical is the half sum of the velocities found by holding the centre of the meter 0·15ft. below the surface and then 0·15ft. above the bed. If the bed is coarse gravel—particles 1in. to 2½in. in diameter—the centre of the meter should be held from 0·30ft. to 0·40ft. above the bed.

(3) In broad streams from 1ft. to 3ft. in depth and having gravelly beds, the thread of mean velocity is from 0·55 to 0·60 of the depth below the surface. The single-point method of holding the centre of the meter 0·58 of the depth below the surface will give good results.

(4) In ordinary streams where the depth varies from

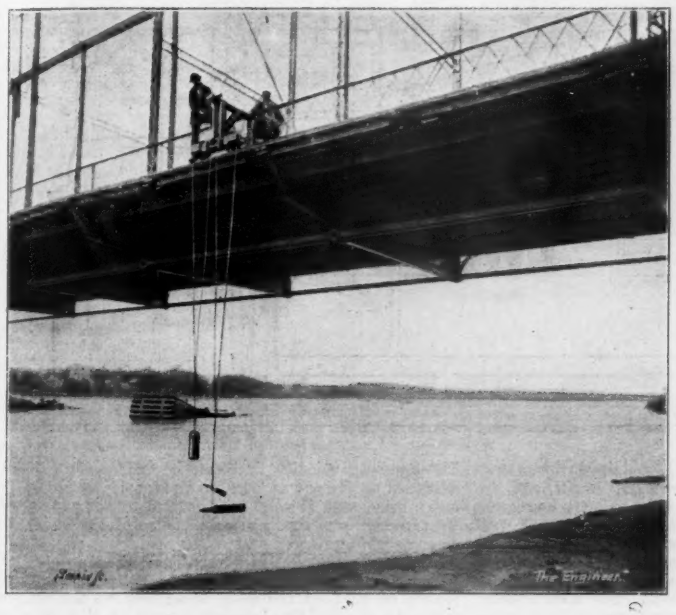


Fig. 3—LOWERING METER FROM BRIDGE

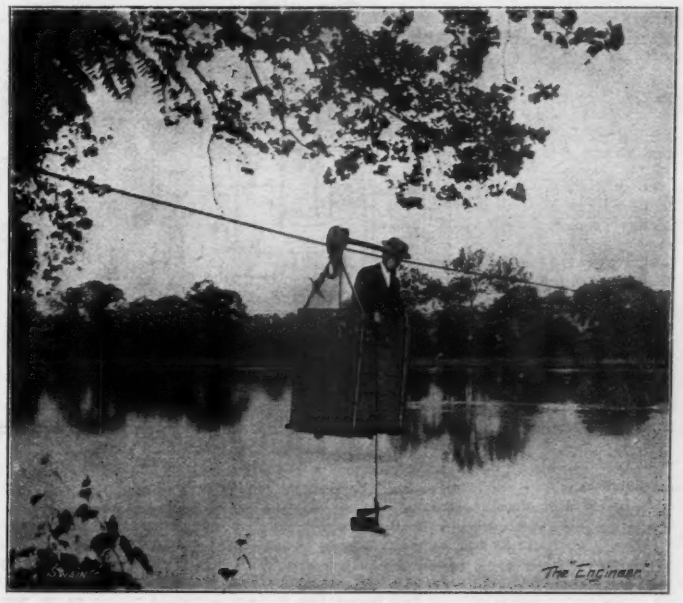
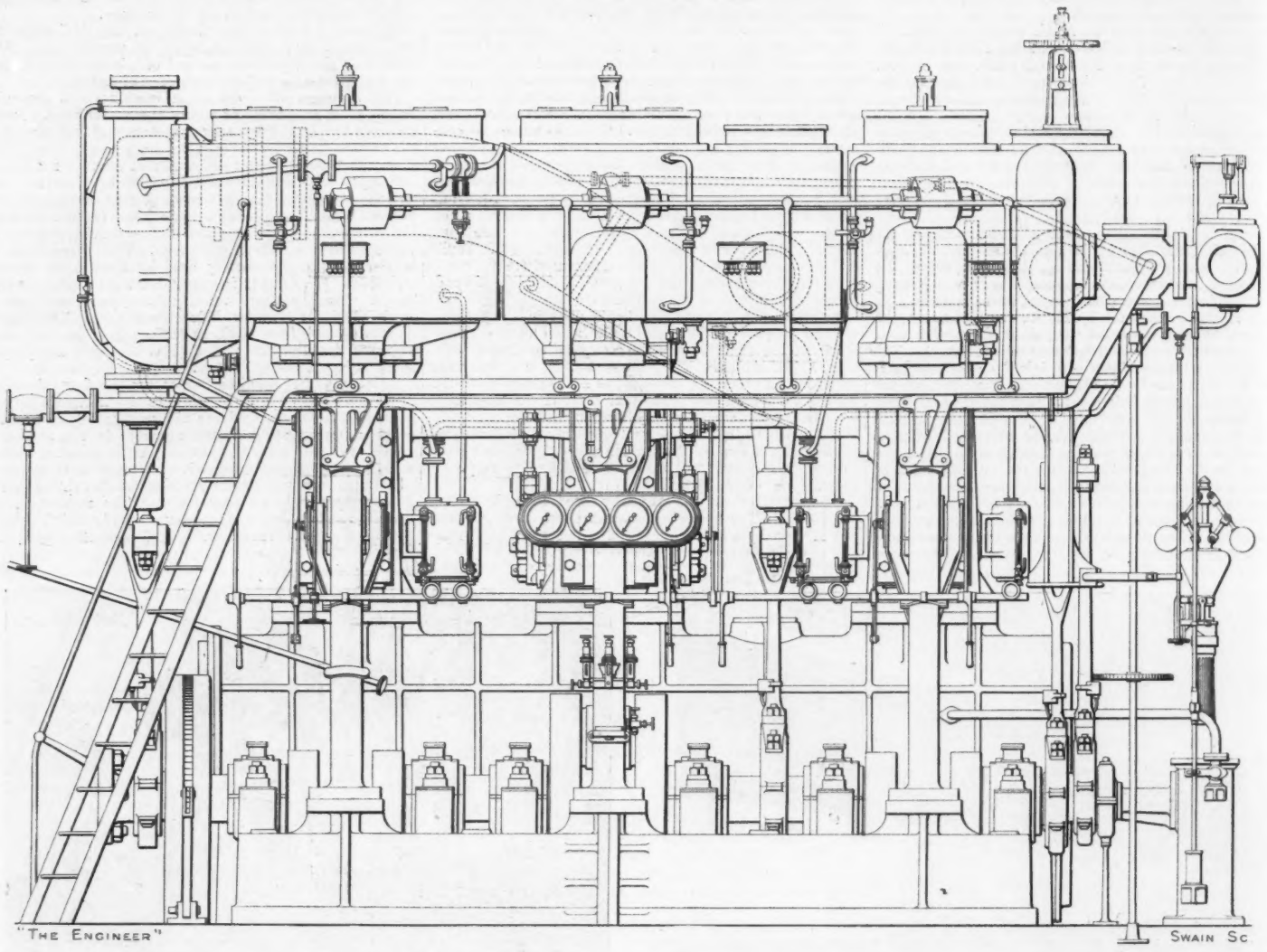


Fig. 4—LOWERING METER FROM CABLE

PUMPING ENGINE FOR THE NEW SOUTH DOCK AT CARDIFF

W. H. ALLEN, SON AND CO., LIMITED, BEDFORD, ENGINEERS

(*For description see page 565*)



1ft. to 6ft., the thread of mean velocity is about 0·60 below the surface.

(5) In creeks and smaller streams having a width of from 20ft. to 40ft., the thread of mean velocity is farther below the surface than in a broader stream of the same depth.

(6) When the velocity is more than 2ft. a second, the centre of the meter should not be held nearer the surface than 1ft.

(7) The top and bottom method—that is, holding the centre of the meter ½ft. below the surface, and ½ft. above the bed of the stream—gives velocities from two to eight per cent. greater than the mean, and this method should only be used where the bed is comparatively smooth and visible.

(8) The vertical integration method—that is, slowly lowering and raising the meter during the observation—is rapid and of use as a check on the single-point method. It gives better results than the single-point method at a bend in a stream, under ice, under logs, or where the conditions are poor.

Most of the gauging stations were situated at bridges, or where these were not available, by cables stretched across the river to be gauged. The meter was lowered from the down-stream side of the bridge, and had a line attached to it running down to it from the up-stream side of the bridge, to ensure it being lowered vertically in the section, as shown in the illustrations, Figs. 2, 3, and 4.

A long series of observations was also made at Cornell University, under the direction of Mr. Edward C. Murphy, in the years 1900 and 1901. The hydraulic laboratory consisted of a canal 16ft. wide, 10ft. deep, and 415ft. long, with concrete bottom and sides and bed slope of 1 in 500. A series of gates was fixed at the upper end to control the admission of the water, and at the lower end to regulate its exit. The weir was fixed at 59ft. below the entrance gates, and consisted of timber baulks, and on the top, 11ft. above the bed of the canal, an angle iron was fixed 16ft. long and 5ft. 3½in. wide, with edges $\frac{5}{16}$in. thick, which formed the sharp-crested weir. Baffles were placed at different parts of the canal to check the velocity of the water as desired.

The meters used were those known as the Price—large and small sizes—the Haskell, and the Heley, the latter held by a rod, the Price and Haskell meters with a cable. During the experiments the water presented a series of waves, but without swirls or boiling. The time required for making a discharge measurement was from 30 to 60 minutes by the ordinary method, 20 to 30 minutes when the observations were taken at six-tenths of the depth, and from 5 to 10 minutes when the depths were integrated. The difference in the results obtained with meters held with cables and with rods was only slight, and the percentage difference decreased as the velocity increased.

Experiments were made with floats as compared with meters. The floats were 6in. cubes of wood, loaded with lead so as to have an immersion of 5½in. These were started near the centre of the canal, and those floats were rejected which came near the sides. The float velocity was found to be 8·3 per cent. greater than the Price meter velocity, and 2·95 per cent. greater than the Heley meter.

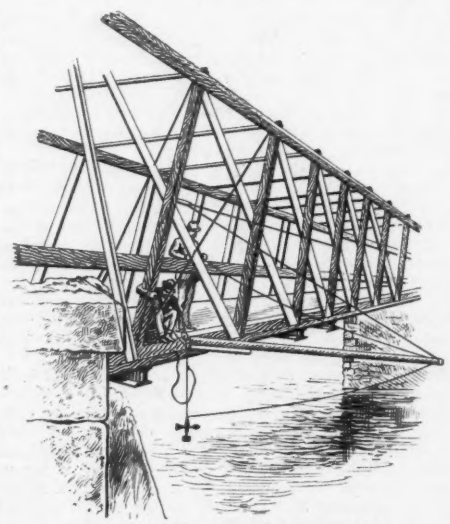


Fig. 2—USE OF CURRENT METER

The meters were held as near the surface of the water as would allow of their working freely.

The general conclusions arrived at, as the result of these experiments, were:—

(1) That discharges measured with current meters agreed with those measured at the weir within 2 per cent. for velocities above 1½ft. per second; for velocities below this the discharge by the Price meter was less than by the weir, and by the Haskell meter it was greater, the difference being 6 per cent. for velocity of 0·75ft. per second. The smallest velocity that can be measured with any degree of accuracy was found to be 6in. per second for the large Price and Haskell meters, and 3in. for the small Price meter; and that when the centre of the meter was closer to the surface than 6in. the result was found to be 9 per cent. too small. Measurements taken at six-tenths of the depth gave a discharge from 2 to 6 per cent. in excess of that by the weir, depending on the ratio of width to depth. The integration method, that is, when the meter is gradually lowered from the surface to the bottom, and then raised again to the surface, during the time of observation, gave an excess of that at the weir. But by using special care in moving the meter at a small speed and at a uniform rate it may be possible to obtain better results than those shown by the experiments.

As an example of the method of recording the velocity of currents by meters in tidal streams, those made in the harbour of Boston, Mass., by Mr. J. R. Freeman, one of the United States Government engineers for the Committee appointed to report as to the construction of a dam across the Charles River, in order to ascertain the velocity of the flood and ebb currents during the various states of the tide, are here given.

As the result of a very large number of observations, it was found that the bottom velocities were very much smaller when recorded by meters than those taken by float. It was also found that regular pulsations were going on in the water. The rise and fall of the rapidity of the click of the electric sounders which recorded the revolutions of the meter were always keenly apparent to the ear, and the velocity of the current on the swell of these pulsations was increased fully 10 per cent., and the power of the current to scour thereby materially increased.

The instruments used in taking the observations were the Ritchie-Haskell current meters in the form used by the United States Coast Survey. These were suspended from the survey boat by wire cables and weighted at the bottom with 60 lb. of lead. A Stearns meter fixed on a staff was also used for velocities near the surface. The heavy weights and thin cables used tended to keep the meters to the vertical and prevent oscillation. Five meters were used at the same time, each being fixed at a different depth between the surface and the bottom, the wires being led to the cabin of the boat and the revolutions there recorded. The meters were always rated after the observations were completed. This was done on the still water of a canal, the meters being attached to a wheeled truck, which ran on a track, the meter being placed in the water at 2ft. below the surface. The truck, with the meter attached, was moved at a uniform speed,

and as each click was given by the meter the time and position of the truck was noted. The truck was drawn along the track by a rope and windlass, the number of revolutions of which could be regulated at will. The minimum velocities measurable were found to be about 0·2ft. per second. These observations confirmed the fact generally known that the flood tide begins to come in at the bottom while the ebb is still running out at the top, and that the early flood tide sets in with greater strength near the bottom. The tide turned from ebb to flood close to the bottom ten to twenty minutes earlier than it did at the top. The results of the survey are given in the report, with sections and diagrams showing the cross sections and positions of the meters on the flood and ebb tides.

VICTORIAN RAILWAYS.

(From our own Correspondent.)

IT has been the outcry for years past in Victoria that Government railways were a failure, and, although repeated alteration has been made in the management from time to time with more or less partial success, it has been left to the new management, which has Mr. Tait as its chief Commissioner, to wipe out the deficit for the first time for the past fourteen years in its first full year of office.

A railway expert once remarked that anyone can make economies by reducing wages, but it takes effective management to create revenue. That this has been done, although helped by the good harvest, together with rational economy in working, is borne out by the fact that the revenue for the year ending 30th June last exceeded that of the previous year by £391,283, with a reduction of 1,113,628 train-miles, or, compared with the previous record year, exceeds in revenue £70,298, with a reduction of 2,112,300 train-miles. The net earnings were the largest ever obtained, and, in spite of the burden of a number of unprofitable lines, was sufficient to meet working expenses and all interest charges, and leave a balance of £519. This result cannot be appreciated unless placed side by side with the deficits of previous years, viz.:—1896, £493,949; 1897, £295,924; 1898, £374,446; 1899, £294,802; 1900, £192,587; 1901, £30,808; 1902, £163,227; 1903, £304,094.

Although a larger traffic has been carried than that of the previous year, the ordinary working expenses have been reduced by £27,284. This is attributed to the large reduction in the mileage of goods and mixed trains, due chiefly to methods adopted during the year for securing the heavier loading of trains and cars, and for preventing the unnecessary movement of empty trucks.

Salaries and wages were reinstated from the percentage reduction in operation the previous year, also the staff were restored to full time working. These items represented, approximately, £100,000. That the working expenses have not been reduced at the expense of the upkeep of the lines and equipment is shown by the systematic method by which the management has undertaken to provide for renewals and replacements. During the year the following amounts have been charged to working expenses:—£84,554 on account of belated repairs to way and works; £28,646 recoups on funds advanced by the Treasury in previous years for replacement of rolling stock and renewal of way and works; and £22,983 towards replacing the deficiency found to exist in the rolling stock and stores.

The introduction of oil motor cars for the use of repairing gangs on light traffic lines has rendered it possible to increase the gangers' lengths on the lines on which they have been put into use by about 50 per cent.

One hundred and two miles of main track have been relaid during the year, 273,523 sleepers were renewed, 47,142 additional sleepers were put into the track, and 136 miles of fencing were rebuilt.

In showing the loan capital, the discounts, cost of raising the loans, and all incidental expenses in connection with same, is taken into account. The capital expenditure also includes £312,027 for cost of surveys of lines not constructed, and seven branch lines that have been closed for traffic, representing an unearned outlay of about £406,513.

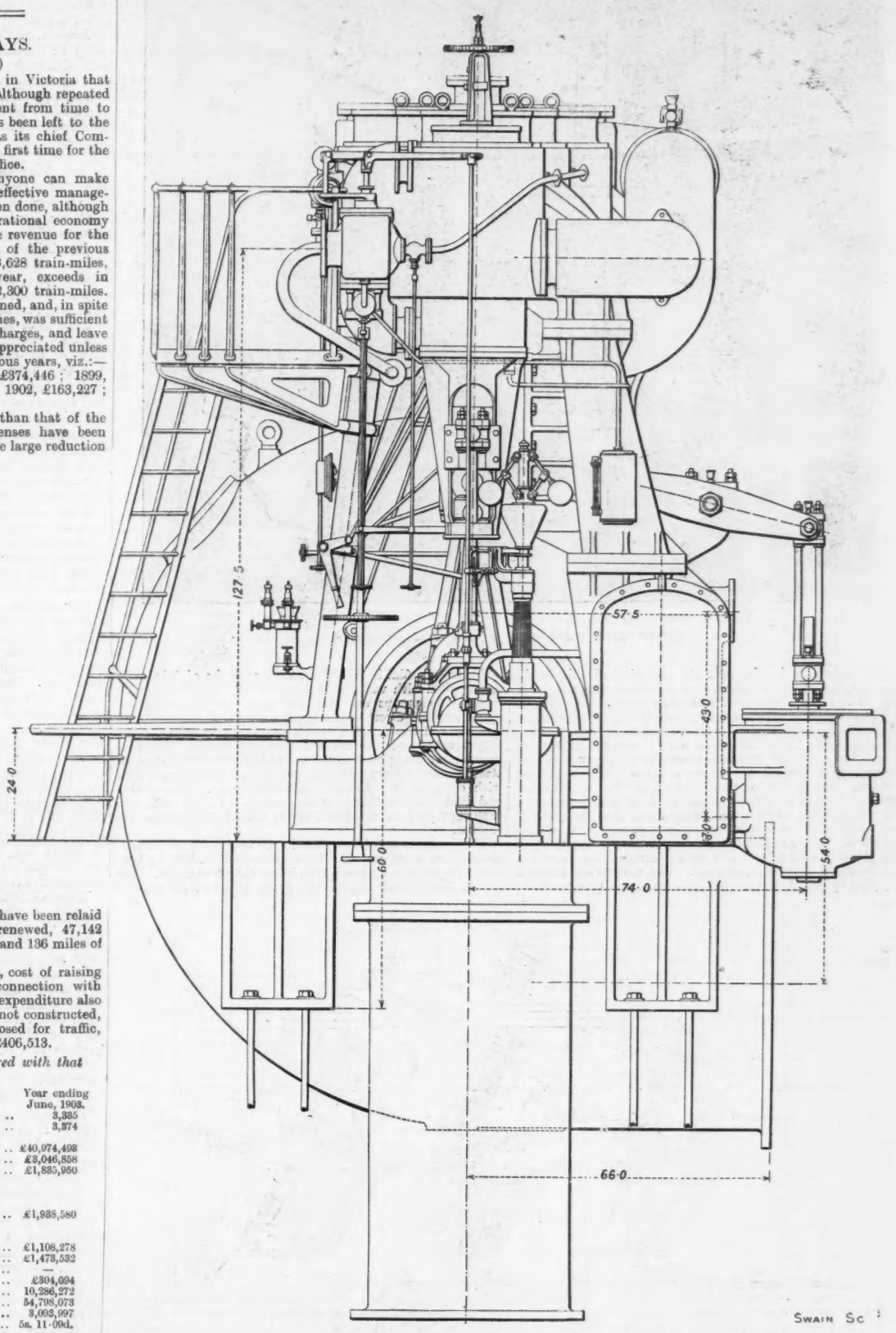
Results of Working for the Year, compared with that for the Previous Year.

	Year ending June, 1904.	Year ending June, 1903.
Average miles worked	3,371	3,335
Total miles open for traffic	3,381	3,374
Cost of construction, including rolling stock	£41,216,703	£40,074,498
Gross revenue	£3,438,141	£3,046,858
Ordinary working expenses	£1,808,666	£1,835,950
Total charges against working expenses, including belated repairs and recoups of funds previously advanced	£1,921,867	£1,938,580
Net revenue over ordinary working expenses, belated repairs, and recoups	£1,516,274	£1,108,278
Interest charges and expenses	£1,515,755	£1,473,532
Surplus	£519	—
Deficit	—	£304,094
Train-miles	9,172,644	10,286,272
Passenger journeys, number	54,282,003	54,798,073
Goods and live stock, tons	3,439,203	3,093,997
Gross earnings per train-mile	7s. 5·96d.	5s. 11·09d.
Working expenses on total charges per train-mile	4s. 2·29d.	3s. 9·23d.
Working expenses on total charges per cent to earnings	55·90	63·63

THE INSTITUTION OF CIVIL ENGINEERS: STUDENTS' MEETING.—The first of the students' meetings for the Session 1904-1905 was held at the Institution on Friday evening, the 2nd instant, the President, Sir Guilford L. Molesworth, K.C.I.E., in the chair, when a paper on "The Midland Railway, West Riding Lines: The Construction of Contract No. 1," was read by Mr. R. T. McCallum, Stud. Inst. C.E. The reading of the paper was followed by a discussion, in which Messrs. H. W. FitzSimons, B.Sc., H. M. T. Hodgson, H. M. Rootham, L. T. Grace, K. E. Aitken, G. S. Sclumper, H. O. Etheridge, J. H. Segrave, and W. H. Shortt, Studs. Inst. C.E., took part.

PUMPING PLANT FOR THE NEW SOUTH DOCK, CARDIFF.

THE Cardiff Railway Company, in order to meet the increasing demands of the coal traffic, has recently completed a large extension to its dock accommodation at Cardiff. In addition to the Bute Docks, which are some 111 acres in extent, the company has also equipped the New South Dock, which has a water area of 50 acres. It is 2550ft. in length, 800ft. in breadth, and 50ft. in depth from the coping, and is capable of accommodating the largest vessels afloat. It is entered from the sea by a lock, which is 850ft. in length and 90ft. in breadth, with a depth of water over the sill of 42ft. at ordinary spring tides, and 32ft. at ordinary neap tides. Two large graving docks, up to 850ft. in length, are about to be constructed, and will be entered from the New South Dock.

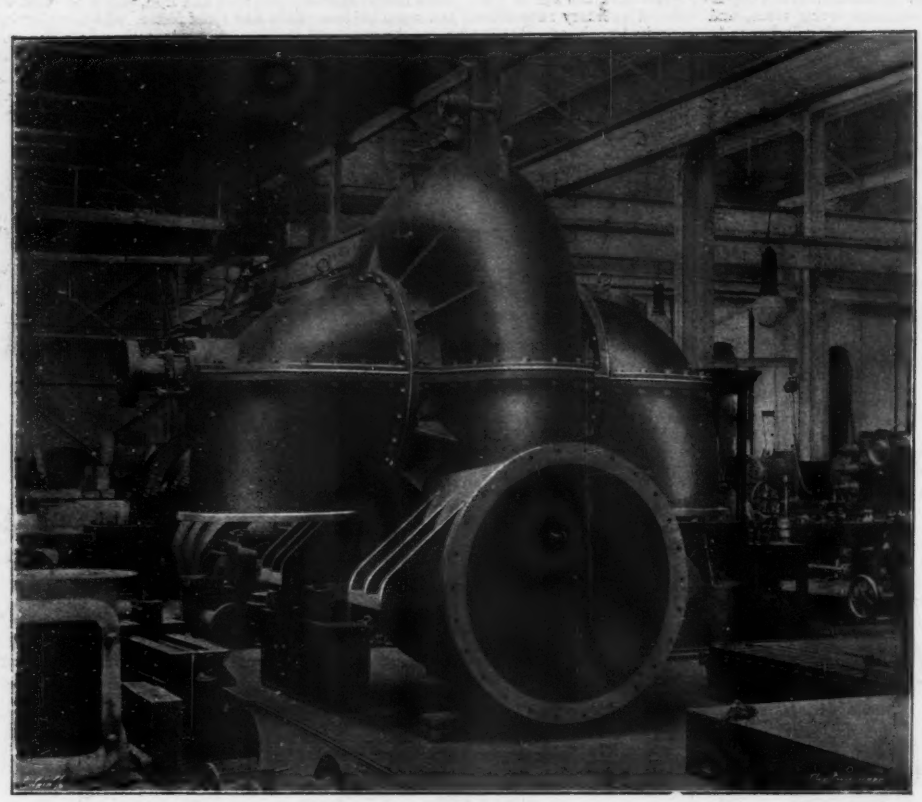


PUMPING ENGINE, NEW SOUTH DOCK, CARDIFF

In order to maintain a constant water level in this large basin, it has been necessary to install a large pumping plant, the contract for the complete equipment of which was let to Messrs. W. H. Allen, Son and Co., Limited, of Queen's Engineering Works, Bedford. As this plant has to deal with an unusually large quantity of water, and presents some novel features in the way of arrangement, it may be of interest to give a somewhat detailed account of the machinery. The main plant consists of three triple-expansion pumping engines, of 900 indicated horse-power, direct coupled to three large centrifugal pumps, each capable of delivering 100,000 gallons of water per minute, against a head of 12ft., at a speed of 105 revolutions per minute. The main engines are of the open marine type, having cylinders 19in. and 30in. and 48in. diameter by 24in. stroke. The annular space outside the liners is arranged to form a steam jacket, being fed with steam direct from the boilers, the intermediate and low-pressure cylinder jackets being fed through a reducing valve. The pistons are of cast iron, and are fitted with Mather and Platt's piston-rings, held in position by cast iron junk rings. The distribution of steam is effected, in the case of the high-pressure and intermediate-pressure cylinders, by means of piston valves, and, in the case of the low-pressure cylinder, by a large double-ported flat valve, which works on a false valve face of specially prepared cast iron, and is provided with the usual balance piston and relief frame, which respectively carry the weight of the moving parts and relieve the valve face of undue pressure. The high-pressure piston valve is on the Meyer principle, the two valves being arranged concentrically and driven by separate excentrics. The cut-off valve is provided with hand adjusting gear, which can be manipulated while the engine is running, thus ensuring economical working under largely varying conditions of load. Each cylinder is cast in one with its valve chest, and is supported behind by a cast iron column, of box section, which carries the slide for the crosshead, and in front by a turned bright steel column. The cylinders are provided with a steel tie-bar, which is secured to cast iron lugs on the front of each, but are otherwise completely isolated from each other. Since the tie-bar remains always at the temperature of the engine-

room, the piston-rods should remain truly parallel under all conditions of temperature. The cast iron columns stand upon a massive box casting, which forms the body of the surface condenser, and are connected together above by steel distance pieces. The exhaust from the low-pressure cylinder is arranged to pass down the centre of the cast iron column into the condenser. The bed-plate, which is of cast iron, is in two pieces, securely bolted together, and also to the front of the condenser body.

The crank shaft is of forged mild steel, and is of the built-up type, the webs being securely shrunk on to the shaft and crank pins. The connecting-rods, piston-rods, and crossheads,

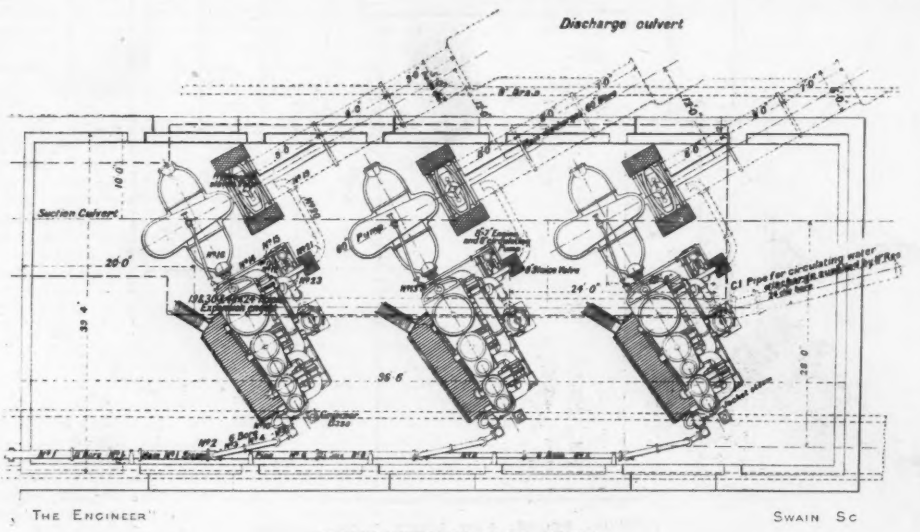


CENTRIFUGAL PUMP—NEW SOUTH DOCK, CARDIFF

excentric-rods, and valve-rods are also of steel; the main bearings, the excentric straps, and the connecting-rod bearings being of cast steel lined with white metal.

The governor is driven by gears from the end of the crank shaft, and is of the Porter type, arranged to act as an emergency governor to cut off the supply of steam, and also to reduce the condenser vacuum when the speed exceeds the normal by a certain pre-arranged limit. The cylinders, receivers, and jackets are provided with all the usual accessories in the way of indicator gear, drain cocks and steam traps, the whole of the valves being manipulated from the front of the engine. The condenser air pump, which is of the Edwards type, is bolted to the back of the condenser body, the plunger being actuated by steel levers and links from the intermediate cylinder crosshead. The circulating water is supplied by one of Messrs. Allen's centrifugal pumps of the "Conqueror" pattern, which is driven by a small separate steam engine. In front of the engine is a large staging of open wrought steel, which permits of easy access to the cylinders, indicators, &c., and is supported by cast iron brackets from the front steel columns. It is provided with hand railing and access steps. The sight-feed oil impermeator and steam pressure gauges are arranged on the front centre steel column. The whole of the cylinders, valve chests, cylinder covers, and receivers are lagged with asbestos, laid on under steam and covered with blued sheet steel. The centrifugal pump, to which the engine is coupled direct by means of solid forged couplings, is of Messrs. Allen's "Conqueror" pattern, having a cast iron impeller of 7ft. 6in. diameter, the discharge pipe being of 60in. diameter. Each pump is provided with two separate suction branches 42in. diameter, which supply water to the pump axially. These three centrifugal pumps are claimed to be the largest pumps of their class which have yet been constructed in this country, each being capable, as stated above, of delivering 100,000 gallons per minute against a head of 12ft., when running at a speed of 105 revolutions per minute. The delivery branch of each pump is fitted with a 60in. hydraulic sluice pipe, having gun-metal facings on both the valve and seat, and a bronze draw rod. The hydraulic cylinders are 6in. in diameter, with a stroke of 60in., and are supplied with water at a pressure of 750 lb. per square inch. The pumps are also provided with the usual air ejectors bolted direct to the pump casing with the necessary opening and closing gear, which can be operated from the neighbourhood of the main engine stop valve. The condenser circulating pumps are also of the centrifugal type, as stated above, and are driven by small single-cylinder engines, with cylinders 8in. diameter and 7in. stroke. The suction and discharge branches of these pumps are all 8in. diameter, each supplying its condenser at the rate of 1200 gallons per minute.

The arrangement of this plant in the engine-house presents some novel features. The latter is some 96ft. long by 39ft. wide, the floor being some 15ft. below the ground line. The centre line of each engine and pump is set at an angle of 60 deg. to the long wall of the room, thus greatly economising space, and permitting a free passage for the water on discharge from the pumps, the centre lines of the discharge piping being at an angle of 30 deg. to the wall of the engine-room.



ARRANGEMENT OF PUMP HOUSE

Messrs. Allen have also supplied a 5-ton traveller for the engine-house as well as the suction and discharge piping for the pumps, thus being the contractors for the whole of the engine-room plant with the exception of the steam piping.

The accompanying engravings show well the design of the whole plant, as well as the arrangement of the various suction and discharge pipes.

LITERATURE.

Dampfturbinen: Entwickelung, Systeme, Bau und Verwendung. By WILHELM GENTSCH. 396 pages, large 8vo., 637 figures and 4 plates. Helwingsche Verlagsbuchhandlung, 1905.

THE plan of this book is entirely different from that of any other yet published on steam turbines. According to its plan no other book on the subject approaches it even distantly in thoroughness of treatment. It must prove of the greatest utility to all those who desire to devote engineering ability and skill to the development of turbines. It is hardly conceivable that a book of this complete character, the result of, to an Englishman, astonishingly patient labour, should be produced in any other country than Germany. An American, or English, or French, or Italian author would deem his time thrown away in expounding any theme in such thorough detail and with such expenditure of labour in historic research. But those who think that engineering development towards perfection is the result of long years of effort on the part of great numbers of workers, and is not due to flashes of individual genius, will believe that none of Herr Wilhelm Gentsch's work in this volume is wasted. Perhaps quite 80 per cent. of the endeavours described in this book to make practically useful steam-turbines have led to no commercial result and to no profit to those who made them. Perhaps not much short of 50 per cent. of them had such inherent faults as to preclude any chance of success. But engineering progress rises to higher things on steps constructed from the wrecks of innumerable hardly-thought-out ideas and vain baffings against physical and financial difficulties. And it is the stupidest and most ignorant of all arrogance to deny sympathy, respect and gratitude, for help received, to the thousands of martyrs whose work, and sometimes whose lives, are sacrificed without material compensation on the altar of human industrial advancement. The perfected structure is built upon a hecatomb of errors and mistakes and unremunerative struggles. We learn what is true and correct and profitable only by trying and eliminating what is the reverse of true and profitable.

Therefore a rationalised history of both failures and successes teaches the lesson to be learnt more thoroughly than it can be taught otherwise. After all most, or at any rate very many, of the failures are comparative; they have turned out unsuccessful because something better has been discovered before they have had time to reap success on the lower standard. What is now productive of commercial profit we may feel certain is only a stage towards other greatly improved constructions, which, when they are introduced, will reduce our present successes to the grade of failures.

Our author, Herr Gentsch, is a patent agent, and appears to have followed with enthusiasm all efforts towards the creation of a steam turbine in the patent records of many countries. He does not profess to have examined all the patents, and certainly does not quote nearly all. But he gives an index of those quoted in his book. This index contains 187 German, 172 English, 80 American, 9 French, 8 Swiss, and 2 Austrian patents; in all 458. As the great bulk of these belong to the last few years, this number "gives one to think" of the number of brains at work on the problem. It should also cool the ardour of those inclined to spend their guineas in "securing" their own entirely novel ideas. The English patents date back to 1784, and 10 were taken out before 1850; 10 more by 1863; another 10 by 1880; still 10 more by 1890; 28 more up to 1895; 47 more by 1900; 28 in 1901; and 25 in 1902. A French patent of 1853 is mentioned, but Germans and Americans come into the competitive field of invention much later.

Herr Gentsch is not a mere patent agent, he is a scientific engineer as well. He seldom or never quotes a patent specification literally. Nor has his book the least resemblance to a series of *résumés* of patent claims. Nor does he restrain himself to chronological order in his references to patents. The historical part of his book is a reasoned account of the rise and development of the very various ideas that have been held in reference to each detail part of the subject; and in dealing with each idea he illustrates it by reference to patents of many periods and of many countries. These references are aided by an almost profuse display of sketches and drawings. The result is a most interesting and informative treatise upon the growth of the steam turbine idea.

This is the most characteristic portion of the author's work. It is specially interesting because of the broad, semi-legal and cynical view taken. A patent agent is not apt to tell his client roughly that his invention is a physical impossibility or is an economic absurdity. His spirit is catholic, and a generous charity guides his calculations of the possibility of utility. There is often more real truth in this attitude of mind than in the narrower dogmatism of scientific cocksuredness. Nevertheless, there are limits, and an honest patent agent will not encourage the patenting of a self-evident perpetual motion. Herr Gentsch describes many devices which most mechanical engineers would consider waste of time to mention even for the purpose of adverse criticism; and perhaps he is right to do so. A germ of truth extracted from the consideration of a plan which is for the most part a crude enormity has often given birth, in the first or second generation, to a method that has proved a brilliant practical success. He is very gentle in his criticisms of the plans he reviews, but he seldom fails to point out the lesson of impracticability or of false physical conception.

In his preface he hints that the real complete physical problem of the working and the design of a steam turbine involves so many complexities that no scientific theories yet applied to its elucidation come near the useful degree of completeness. This is the ground reason for the recommendation of the historical method of study; the method of examining all that has been done unsuccessfully as well as successfully.

It is true that no mathematical investigations of steam-

turbine action yet published in treatises approach an even fairly complete account of all the important physical influences at play. For example, take one point referred to incidentally on page 246 of the volume under review. All effective turbine driving force is due to the curvature of the paths the steam is forced to follow in flowing through the wheel. Now, over 3000ft., or say 1000 metres per second, is a speed often reached in modern turbines of the Laval class, and this in the flow through a passage curved to less than ¼in., or, say, 10 mm. The centripetal velocity acceleration in this curved motion is

$$\frac{v^2}{r} = \frac{1000^2}{\cdot 01} = 10^8 \text{ metres per sec. per sec.}$$

In passing it may be noticed that Herr Gentsch, by arithmetical error, states this to be 10^7 instead of 10^8.

Gravity acceleration is 9.81 m./sec.^{2} Taking it roughly as 10, it is seen that the turbine-flow centripetal acceleration is 10 million times as great as that of gravity. In other words, each portion of steam presses outwards along the radius of its curved path with a force equal to 10 million times its own weight. The weight of 1 c.cm. of water is 1 gramme, and that of the steam flowing with the above velocity may be less than this in the ratio of, say, 15,000. Thus the centrifugal force of 1 c.cm. of this steam will be about $\frac{10^7}{15 \times 10^3}$ grammes $= \frac{2}{3}$ kilo. Thus in any cross section of such a curved stream the pressure at its outside convex surface will be $\frac{2}{3}$rds of an atmosphere = 10 lb. per square inch greater than 1 cm. further in towards the centre of curvature. Mixing up English and metric measures for the sake of obtaining a simple numerical result, this may be stated as an increase of pressure of 1 lb. per square inch per 1 mm. radial thickness of the stream. Now the velocity attained depends on the drop of pressure from that in the boiler, so that it is clear that the streamlets of steam on the outer active side of the bucket passage do not attain so high a velocity as those on the inner side at the same cross-section. Across the section the streamlets flowing side by side have different velocities; and those on the outer side drag backward those on the inner side, and *vice versâ*, by viscous interaction. This viscous interaction involves loss of energy; it is certainly one of the sources of inefficiency in steam turbine action. But this variation of velocity across the section of the flow consequent upon transverse variation of pressure, due to centripetal acceleration, is always ignored in the mathematical calculations made in the published treatises. The above statement of this disturbing influence is itself quite incomplete, because it proceeds as if the steam density were uniform across each section, whereas, of course, it varies along with the pressure.

This is only a single example illustrating how a really complete physical theory of steam turbines would be much more complex in its mathematics than anything yet attempted. It is Herr Gentsch's insight into the details of the mechanical working of his favourite machines that leads him to lay comparatively little stress on mathematical calculations, and a great deal more upon the study of what has been actually attempted in material form, and the practical results of these attempts.

The author is dissatisfied with the common classification of turbines into "pressure" and "impulse." He prefers to classify them as "pressure" and "velocity" turbines, and explains that there are really no pure "pressure" turbines, inasmuch as, in every existent form, much of the head is transformed to kinetic energy before the moving wheel is reached. We think that "kinetic" would be a very much better name for his second class instead of "velocity"—Geschwindigkeits. He subdivides the "velocity" turbines into those with acceleration inside the running wheel and those in which acceleration takes place only before the wheel is reached.

No space can be afforded here to notice the innumerable interesting and curious constructions described in the first part of this book. Regarding many of them, the interest would have been greatly enhanced if more information were given anent the working results obtained. In many cases one strongly suspects that the tested horse-power developed must be zero or nearly so.

On page 25 there is illustrated a strange design of wheel on which concentric rings of blades are mounted on one wheel, with intervening "rest" chambers between them, these chambers being parts of the rotating wheel enclosed between its rotating side walls. If any horse-power has been developed by the flow of steam through this wheel (Girard, Eng. patent, 1855), it would be of much scientific interest to have it measured and to find out the reason why it should exert a driving force. The 1898 English patent of Rateau, Sautter, Harle and Co., and the Wilson 1848 English patent seem specially interesting from the historical and scientific points of view. It is gratifying to notice how generally the double-flow-balance system has been followed in the designs of all countries.

Many designs have been made in which jets of steam, issuing tangentially from the rotating circumference of the wheel, impinge upon a fixed ring of teeth-like blades; and in a considerable number the frictional resistance offered by a plain cylindrical casing to the tangential outflow of the steam has taken the place of the teeth. Independently of any question of economy, it would be interesting to know how much, if any, effect is producible by the insertion of such teeth or other obstruction to free discharge.

The seventh chapter deals with means of lowering the rotative speed of turbines, and the eighth with the influence of, and methods of connection with, condensers, as also the forms of condenser and of air-pump used, and means adopted to drive the pump.

The ninth chapter has to do with superheating of the steam, and it is pointed out that the practicability of a very high degree of superheat depends upon the absence of all need of cylinder lubrication. Then follows an interesting chapter upon the internal resistances, in which we learn that the losses through impact upon the edges of the bucket blades are much more serious than the actual frictional losses.

Nextly comes a very long and complete account of the governing methods and mechanisms that have been employed; and then the important subject of reversal of rotational direction is fully dealt with.

The following portion of the book gives theoretical calculations of the proper sizes and shapes of the entrance guide-blade or nozzle passages. Here Zeuner's investigations, in his Leipzig lectures of 1899, are mainly relied upon. A *résumé* of the experimental results of various investigators is given. It is pointed out that practical disadvantages, such as irregular scattering and spraying, result from pushing efforts after maximum theoretical efficiency to extreme limits. The shapes and methods of tooling and assembling these parts adopted in the modern successful patterns of turbine are described in some detail; and the same is done in the next chapter in regard to the buckets or blades of the running wheel, where some of the special tooling machinery employed is illustrated. These important details are dealt with far more thoroughly than in any other book previously published.

The book offers certainly amusing contrasts with other treatises on the same subject, in its rapid polishing off—in, say, three pages hidden in the midst of 100 pages of constructive description—of all the mathematical calculation thought necessary or trustworthy. A useful chapter of 16 pages describes the various means whereby the serious losses by steam leakage are sought to be minimised. Bearings and glands are other details, each treated of separately in some detail. A lengthy account of the modes of combining turbines with dynamos is given, along with very full records of test results in running. The book finishes with two short sections upon turbines for land locomotion and those for marine propulsion. A useful index is found at the end.

We welcome this treatise as the best yet published on steam turbines, although we think that it boycotts mathematical calculation to too great an extent. May we hope that some English or American author will produce, at an early date, an equally worthy and still more up-to-date treatise in our own tongue?

A RENEWABLE AND A CONTINUOUS RAIL.

WE have received from Mr. H. W. Perry, Executive Engineer, South Indian Railway, Trichinopoly, a pamphlet, which sets forth proposals for modifications in the construction of railway track of a very far-reaching kind. The scheme, which, we may say, is very fairly put forward by Mr. Perry, will be understood in a moment from the two sections which we give. A renewable rail is made with a separate head, which is fitted on to the body of the rail as shown in Fig. 1, which is a reduced section of the standard Indian State Railway 75 lb. rail. The head of this rail is 2⅜in. wide and 1¼in. deep, and contains about 35 lb. of metal to the yard. The shaded portion of the head represents about the maximum that

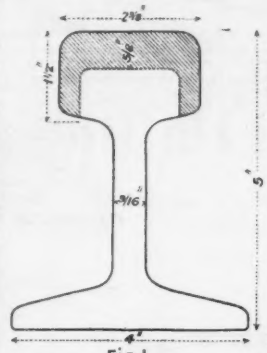


Fig. 1.
Standard 75-lb. Broad Gauge Rail.

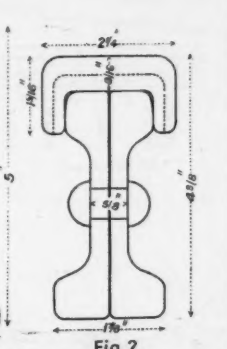


Fig. 2.
Proposed 60-lb. Continuous Rail.

could safely be allowed to be worn away in use, supposing the rail to be changed, when half worn, from one to the other side of the track, so that both sides of its head may be exposed to the wear of the flanges of the wheels. The weight of this shaded and available portion is a little less than 20 lb. to the yard. As soon as it is worn away, the whole rail, which then weighs 55 lb. or 60 lb. to the yard, has to be taken out of the track, and a new rail has to be put in in its place. The removed rail is now quite useless as a rail, and can only be used for fencing, roofing, &c., or be sold for these purposes, in which case it may fetch about Rs. 1·8 up to Rs. 2 to the yard. This is about half the cost of the new rail which has to be bought to replace the old one. The inventor goes into calculations, which we have no doubt are accurate, to show that about 65 lakhs are spent every year in India on renewing rails alone, and that after every allowance has been made for the value of old rails, a very large sum indeed could be saved by the adoption of the new system.

The continuous rail is shown in Fig. 2, which explains itself. The fish-plate is, of course, got rid of. The section shows, to a reduced scale, a 60 lb. continuous rail for a metre-gauge line.

As it may be urged that the cap will get loose, Mr. Perry deals with that objection. He writes:—"The principle of making wearing parts detachable, so that they can be easily renewed, is recognised and adopted in nearly every other contrivance in which iron is used, and there appears to be no reason why it should not be applied to such important and hard-used things as rails. A broad-gauge rail, very similar to the present standard 75 lb. one, has a renewable cap fitted on to it, and which weighs only about 85 lb. to the yard, inclusive of the cap. The latter is simply a channel iron in section, and can be laid anywhere on to the head of the rail. It is secured and gets its grip by having the slope or inclination of its inner sides made slightly steeper than that of the sides of the head of the rail on to which it fits. If the inner sides of the cap are vertical, the sides of the head of the rail should be inclined slightly outward, as shown in the figure. By varying the relative degree of the inclination and the extent of the surfaces in contact, any desired amount of bite or grip may be obtained. The weight of an engine or other wheel then rolling over the rail and cap presses down the latter on to the former, and does so with such force—four or five tons at the least—that it practically becomes a part of the head of the rail."

Mr. Perry has had much practical experience with rails, and no doubt understands his subject. We venture, however, to doubt that the economy claimed would be secured. The cost of the compound rail would be more than that of the normal rail per yard. The weak point in the proposal is, however, the probability that the removable head would stretch under the rolling-out action of the tires, and so become loose.

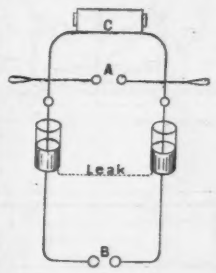
IGNITION IN INTERNAL COMBUSTION ENGINES.

ON Monday evening last the opening meeting of the autumn session of the Automobile and Cycle Engineers' Institute was held in the lecture-room of the Institution of Mechanical Engineers, Storey's-gate, with Mr. H. Austin in the chair. An interesting lecture on the ignition of gaseous mixtures was delivered by Sir Oliver Lodge. It began with a general discussion of the nature of inflammation, the conditions which were necessary to produce it, and the conditions which accelerated or retarded it. The lecturer pointed out that flame, started at one point by the application of external heat, had to be conveyed through the body of the gas by its own agency. He imagined an active particle at the centre of a sphere of influence, surrounded by a number of molecules ready to continue the action, and he explained that, by increasing the number of such molecules in the neighbourhood of the active agent, the rate of inflammation could be increased. The obvious methods of effecting this end were to increase the richness of the mixture or to compress more molecules into a given space; but there was a third method. The molecules were always in motion, with the ordinary motion of the molecules of a gas, and those outside the sphere of action, by moving through it now and then, produced slow combustion. If, however, the temperature of the gas was raised, the rate of motion of the molecules was increased, and the speed of the spread of the flame through the mixture was augmented. The question of the effect of neutral gases, and particularly of the influence of an excess of one or more of the active gases, was then discussed, the lecturer expressing the opinion that an excess of the lighter gas increased the rate of explosion, for the very reason that its molecules moved more rapidly than the molecules of the heavier gas.

Experiments were then made to show (1) that the rate of combustion could be measured, a long vertical glass Bunsen burner being used for the purpose, the rate of progress of the inflammable mixture up the tube being checked by controlling the gas supply until the rate of combustion down it was just in excess, when the burner slowly struck back; and (2) that combustion could be entirely arrested by cooling the flame. For this purpose the familiar experiment of the copper coil and the burning taper was employed, the experiment leading to the remark that the efficiency of the gas engine might be greatly increased if cylinders with red-hot walls could be employed—a consummation which the lecturer appeared to consider not wholly unattainable.

Different forms of flame, hot-tube, and catalytic ignition devices having been described by means of slides on the screen, the lecturer entered upon the subject of electric ignition. He explained with a great deal of care, and illustrated by a few simple experiments, that electricity possessed actual inertia, and he showed, by using a circuit having large self-induction, that it took quite a measurable time for the current passing through that circuit to reach its full strength. Having shown that the current had inertia, he exhibited the effect of suddenly arresting it by interposing a resisting body in its path. The body selected was air, and it was interposed by breaking the circuit; the result was a spark. The nature of the inertia of the alternating current was illustrated by the use of a heavy pendulum. It was shown that whilst a thin board might be struck without damage by the weight near the end of its swing, it was cracked across if it met the weight half-way. Thus the necessity for using the spark at the moment of greatest current intensity in magneto machines was enforced.

After this explanation of the theory of the electric spark, a number of different forms of electric igniters were discussed with the aid of diagrams and actual samples, and the lecture was concluded by an exhibition of the peculiar properties of what is known as the "A and B" spark, and which has been transformed by Sir Oliver Lodge's son from a striking laboratory experiment into a powerful igniter for gas engines. The arrangement of the apparatus is shown diagrammatically below. A high-tension coil, C, is connected to the inner coatings of two Leyden jars, of which the outer coatings are connected by a "leak" and by a circuit, which is interrupted at B. A pair of discharging knobs are placed at A. Whenever the jars become overcharged a primary spark occurs at A, and at the same instant a secondary spark at B. The power, if it may be so called, of this secondary spark is irresistible. It was shown by experiment that it was rather increased than diminished in intensity by connecting the knobs B by a piece of wet blotting paper; that it could not be arrested by grease or moisture; that a carbon rod placed between the two points was powerless to prevent its occurrence; and that even under water it was as violent as in dry air. These tests were shown both with a powerful influence machine and long spark and with an actual sparking plug designed for use with internal combustion engines. The advantages of the device are that the condition of the sparking points within the cylinder is immaterial, whilst the points which must be kept in condition—that is, the points between which the A spark occurs—may be placed anywhere in an accessible position.



At the close of the lecture, which had held the attention of the audience for nearly two hours, a very hearty vote of thanks was accorded to Sir Oliver Lodge.

HOT SPRINGS AND THE SIMPLON TUNNEL.

No. VII.—(CONCLUSION).*

HAVING regard to the present advanced stage in the boring of the Simplon Tunnel it is desirable to conclude these notes with some particulars of the latest operations in progress at the time of writing, as also of the exceptionally heavy constructional work now being completed throughout the tunnel, together with recent progress made upon the approach line railways on either side of the Alps.

In our preceding article mention was made of the possibility of effecting the first encounter between the Italian and Swiss headings by means of the secondary tunnel "No. 2."

This is, in fact, the plan now adopted. Operations at all other headings are suspended, and even with this heading, No. 2 of the Italian side, despite the concentration there of all the energies available, the difficulties are proving such as to render advance very slow, indeed so much so that, to perforate the short length remaining between the two headings of No. 2 tunnel, a very considerable delay is to be feared, judging from the present rate of advance and also from the unstable nature of the soil to be traversed.

Actually, the main tunnel heading No. 1 at the Italian side ends at kilom. 9·100—the point reached on September 6th last, and as is shown in the sketch-plan on page 385. The explanation for the cessation of the work of advance in the main tunnel may be gathered from the following particulars.

The last detonations of the mines in the heading-face of No. 1, on September 6th, revealed the fact that the unstable calcareous mica-schist, or micaceous silicated lime-stone, prevailing up to that point, ceased suddenly at a dislocation or fault in the stratifications, beyond which there appeared to be an almost pure limestone of light grey colour; but this, and also the nature of the contact between the two different rocks, could not be verified, for, simultaneously with the blasts, hot water under heavy pressure began to pour through the loose broken surface of the crown, and, while attempts were being made to remove the spoil, the whole of the heading crown collapsed, pinning beneath it one of the trucks—not yet extricated—and immediately preceding the voluminous inrush of heated water already described. This water enters through the crown on the N. E. side, and appears to correspond with the slip in the stratified mass. Subsequently, fall after fall of the crown occurred, until the whole working caved in, and since this accident the extremity of the heading has remained inaccessible, for, as has already been explained, the Italian side is inadequately provided with refrigerating plant, and until a complete system of cold-water mains and spraying apparatus can be laid down, the atmospheric temperature at the heading of No. 1 is far too great to permit the resumption of work there with rock borers. At the time of the first irruption of hot water there remained 2 kilom. length of cold-water mains to be laid, about 600 m. of drainage canal to make in tunnel No. 2, and a considerable length of inverted arch to be built in the same passage. These works had to be completed in haste, the last of the transverse passages bored and revetted—to serve exclusively for the drainage of the hot water in No. 1 heading—and preliminary cooling water plant installed in both tunnels. The two centrifugals, run by turbine, in the pumping station at kilom. 4·700 were not got to work until September 12th, in forcing the cold water from the great cold spring at kilom. 4·380—see view Fig. 1—and machine boring was resumed in No. 2 on October 21st, but only for a few days, and from which time recourse was again had to hand boring, as has been largely necessary throughout the piercing of this latter, and amounting to rather over one-half the total excavated, whereas in the main tunnel this proportion only amounts to about one-eighth. The rock encountered for a long time past had been notably free from water—infiltrations—such small springs as were opened being, however, strongly charged with gypsum and occasionally with sulphur—in one case a spring, forming a curtain across No. 2 tunnel giving off such exhalations of sulphuretted hydrogen as to cause trouble to the miners, despite the excellent ventilation. The last 200 metres traversed were almost quite dry up to the great hot-water springs which clearly defined the southernmost limit of their region, the rock being a grey granitiferous mica-schist, nearly always very calcareous and unsafe, cut through, here and there, with thin layers of a mottled-grey limestone, and veined with quartz and deposits of calcite running parallel to the stratifications, which latter, after the ninth kilometre, became broken with a series of dislocations forming a jumble, exceedingly unreliable, and necessitating close timbering and lagging, just previous to entering the hot-water region. In this calcareous mica-schist a very few garnets were discovered.

FIG. 1—COLD WATER SPRINGS IN ITALIAN HEADINGS

The flow from the hot water spring has now diminished, and, as far as it is possible to gauge it, the present volume would be about 3600 litres per minute, while its temperature shows a slight tendency to augment, having increased from 44 deg. Cent. to 45·4 deg. Cent.—which augmentation is not impossibly connected with the diminished speed of the stream in its flow through the heated rock in higher regions. On the other hand, its degree of hardness has fallen from 142 deg. to 136 deg. in the space of a month, this diminution being attributed to the fact that the pocket of water from which it surges was more densely charged with gypsum in its lowest depths than in the higher level of water at present in course of evacuation. It is usually inferred that the great spring at the south side of the workings is not connected with those of the north headings, and that these latter are not related to each other. These conclusions have been arrived at by reason of the great variations and fluctuations in their individual degrees of hardness, those of the Swiss workings being variously 60 deg. to 80 deg. less than the spring at the Italian ends. But nevertheless it seems possible that in flowing through different species of rock the various streams originating from a single source would be very susceptible to change, both in heat and in hardness. The definite solution of the origin of the heated water in the Simplon Tunnel for the present, however, remains a subject for very interesting geological study.

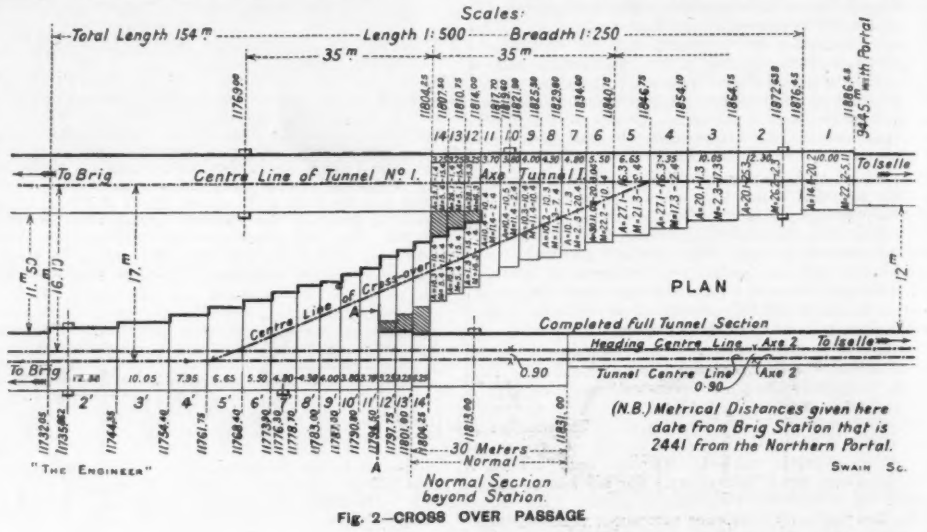


FIG. 2—CROSS OVER PASSAGE

The effect of the heated water, directly or indirectly, upon the temperatures of rock and of the atmosphere in the tunnels is very appreciable. For instance, while the rock heat in the main tunnel at the ninth kilometre from Iselle has been reduced in one month, by the aid of cooling appliances, from 42·4 deg. to 37 deg., the rock heat in the secondary tunnel traversed by the hot drainage water has increased—amounting, even back at the eighth kilometre, to 2·6 deg. Cent. additional, while the air temperature from the fifth to the eighth kilometre has increased by 2 deg. and 7 deg. Cent. The air temperature in the main tunnel, No. 1, at the ninth kilometre increased from 27 deg. Cent. to 32 deg. Cent. in the same interval. At the heading of No. 2 tunnel the temperature has increased slightly, being now 28 deg. Cent. during boring and 29·7 deg. Cent. during blasting and spoil clearing—the maximum attained in the latter operations being 32 deg. Cent. The flood of water for the whole tunnel has subsided with the change of season, being now 880 litres per second at Iselle.

The following details show the state of advancement of the masonry work at the two ends of the tunnel. At the Italian side this has proved very expensive work, as, owing to the unstable rock traversed and the nature of its composition, numerous sections of the parallel tunnel No. 2 have had to be revetted—often with inverts as well as crowns. An aggregate of 1796 m. length in No. 2 have been revetted, as compared with the 1003 m. lengths in the same tunnel on the Swiss side; and at the Italian side in No. 2 tunnel it has been necessary, so far, to lay inverted arches through a total length of 1405 m. in about thirteen different places.

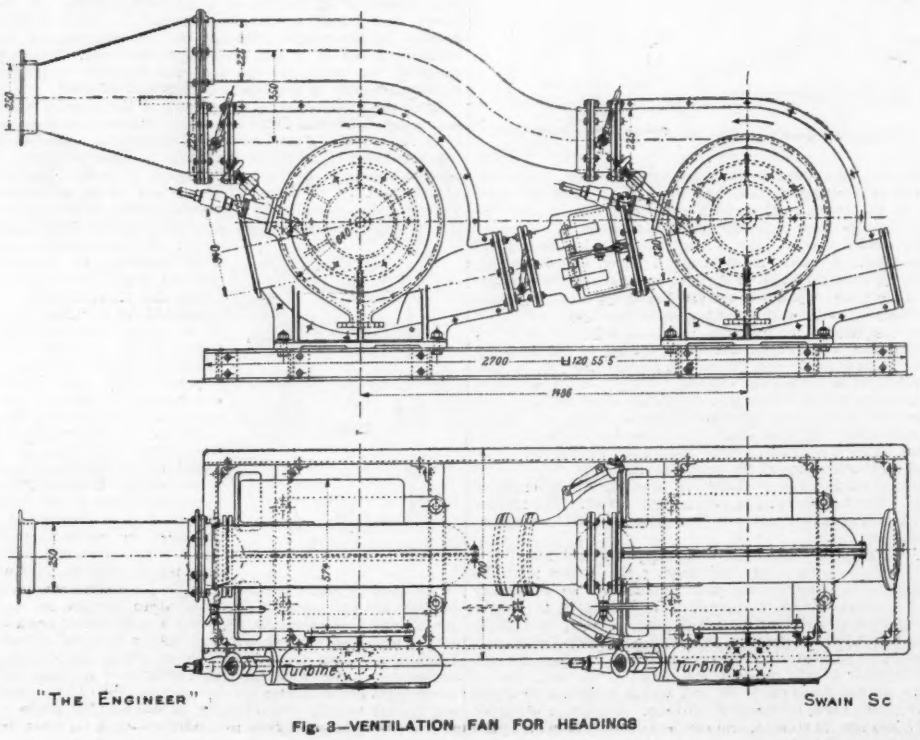


FIG. 3—VENTILATION FAN FOR HEADINGS

* No. VI. appeared November 18th.

In the main tunnels the inverted arch rings have an aggregate length of 880 m. at the Italian side and 1062 m. at the Swiss side. The total length revetted in the main tunnel, No. 1, is now close upon 10 kiloms. at the Swiss side and a little over 8 kiloms. at the Italian side; consequently there remain about 1¾ kiloms. length to complete the tunnel lining. The progress with this work has been retarded at the Italian side because of the irruption there of hot water, and the total revetments carried out at both ends of the tunnel now only averages 124 lineal

Fig. 4—HIGH LIFT CENTRIFUGAL PUMP AT BRIG

metres per month (2566 cubic metres), in place of 227 m. effected in the first half of the year; thus, even supposing a rate of 200 m. daily, this work would involve another nine months' time. The immense masonry lining built in the decomposed mica-schist of mush-like consistency, encountered about kiloms. 4·457 to 4·504 from the Iselle portal, is now apparently the strongest part of the tunnel, having given no signs of movement or of incipient defects. This great constructional work in both tunnels was carried out in the manner already described in our articles upon the construction of the tunnel, in 1902-3.

At present the masonry lining at the Italian side averages 11·10 cubic metres per metre run of tunnel length, and of this 4·47 cubic metres are outside of normal section. The walls now average 5·40 cubic metres, the crown 5·20 cubic metres, and the inverted rings, where employed, 4·39 cubic metres per metre run at the Italian side, and as compared with the cubes adopted at the Swiss side of 4·45, 4·72, and 3·14 respectively; the latter figure for the invert being slightly less than that employed earlier in the year. For the revetment at the Italian side, 168 kilos. of lime and cement are used per cubic metre of masonry in tunnel No. 1, and at the Swiss side for tunnel No. 1, and in the large siding in No. 2, this consumption is 133 kilos. In the lining of the smaller tunnel No. 2 at the Swiss side 0·5 cubic metre of materials were used per lineal metre and at the Italian side 1·22 cubic metre.

Together with the work mentioned there is usually a certain amount of reconstruction of revetment in progress necessitated by the deformation of the profile due to live pressure, as from gypsum, or to a movement in the rock, producing fissures in the lining. For instance, on the Swiss side a surface of 33 square metres of arch crown in No. 1 has been renewed where it was fissured by a movement of rock, produced, presumably, by detonations during the work of enlarging the primitive section of the adjoining, No. 2, heading to form a siding. The whole length between the north and south branches to this siding in No. 2—that is, between kiloms. 8·857 and 9·480, and shown in the plan on page 415—has developed numerous faults in the lining, these occurring in the crown inverted arch and, occasionally, in the walls, and where defects in the concrete blocks in the crown have also been remarked. In one place, the inverted arch had been forced up—between kiloms. 8·950 and 9·000—and is being renewed, while fissures have been noted in the great vault—the first ring—at the south branch to the tunnel siding. The method of construction employed for these branches is shown in detail by the Fig. 2.

At the Italian side recent reconstructions have been limited to the inverted arch in tunnel No. 2—about 15 metres length between kiloms. 7702 and 7723—and to a renewal of the beton channel drain in the same heading, where a movement of the rock had deformed it in parts between kiloms. 6·600 and 7·360. A large channel drain is in course of construction in the main tunnel, No. 1, and is finished up to near the fourth kilometre from Iselle. The work of construction is supervised by resident engineers of the Federal Railways.

In advance of the masonry work, excavation to normal section is proceeding at an average rate of 197 cubic metres per day, equivalent to a total excavation, including the work of the rock borers, of 86 cubic metres per metre run, or 4·47 cubic metres beyond normal section. The channel drain requires an excavation of 1½ cubic metres per lineal metre. The consumption of dynamite has averaged, recently, 4·52 kilos. per cubic metre of machine boring, and 0·54 kilos. per cubic metre of hand excavation. The total average consumption for all work is 1½ kilos. of dynamite for each cubic metre excavated. At the Swiss side the excavation for enlargement requires 0·72 kilos. of dynamite per cubic metre. At the Italian side the excavation by machine amounts to 23·6 per cent. of the total in No. 1 tunnel.

The daily consumption of dynamite is about 387 kilos., and the principal store is in the tunnel No. 1, about 3 tons being kept in three manholes near to the entrance and from these it is delivered once daily to secondary stores convenient to the headings and to the enlargement areas. A store is also made in a transverse passage near the third kilometre for the excavation of the large channel drain. The concrete lining for this latter amounts to about 1 cubic metre per lineal metre.

Some changes have recently been effected in the means employed for carrying out the work. Now horses are no longer employed, even in the Italian headings, and a compressed air locomotive has been added to the equipment here, with other plant no longer needed at the north side. At the Italian heading of No. 1 tunnel the auxiliary ventilation has been suppressed for the time being. The type of heading fan employed—at present only for the needs of No. 2 tunnel—is shown in

Fig. 6—HOT-WATER DRAIN DISCHARGE

Fig. 3. These fans can be run up to 2500 revolutions per minute by means of small turbines of 10 horse-power, consuming up to 1·8 litres of water per second, the air being delivered any distance up to 650 m., although a length of from 325 down to 21 m. of 460 and 360 mm. pipe usually suffices for the ventilators beyond the last driven cross passage. The refrigeration of the secondary ventilation is sometimes effected by means of a cold-water pipe 50 mm. diameter, pierced with holes every 10 m. The walls of the main tunnel are also refrigerated by the same means, and on both sides of the passage.

At the same side, Iselle, the temporary air passage from the main ventilators, passing into tunnel No. 2 at some distance from the portal, has been abandoned for the definite system of air passages which will be employed until such time as the two tunnels are completed for the through circulation of the air, as already described on page 58, January 16th, 1903.

The portal at Iselle is now built up as far as is required for the traffic necessities in No. 1 tunnel.

At Brig also the portal is completed to a like extent for the needs of the same tunnel, No. 1, but in this case the ventilator house is connected directly to the portal.

In the shops at Brig all machines employed exclusively for the maintenance and repair of the fifteen rock borers, now out of service, have been dismounted. The pair of high-lift centrifugal pumps in the power-house for supply-

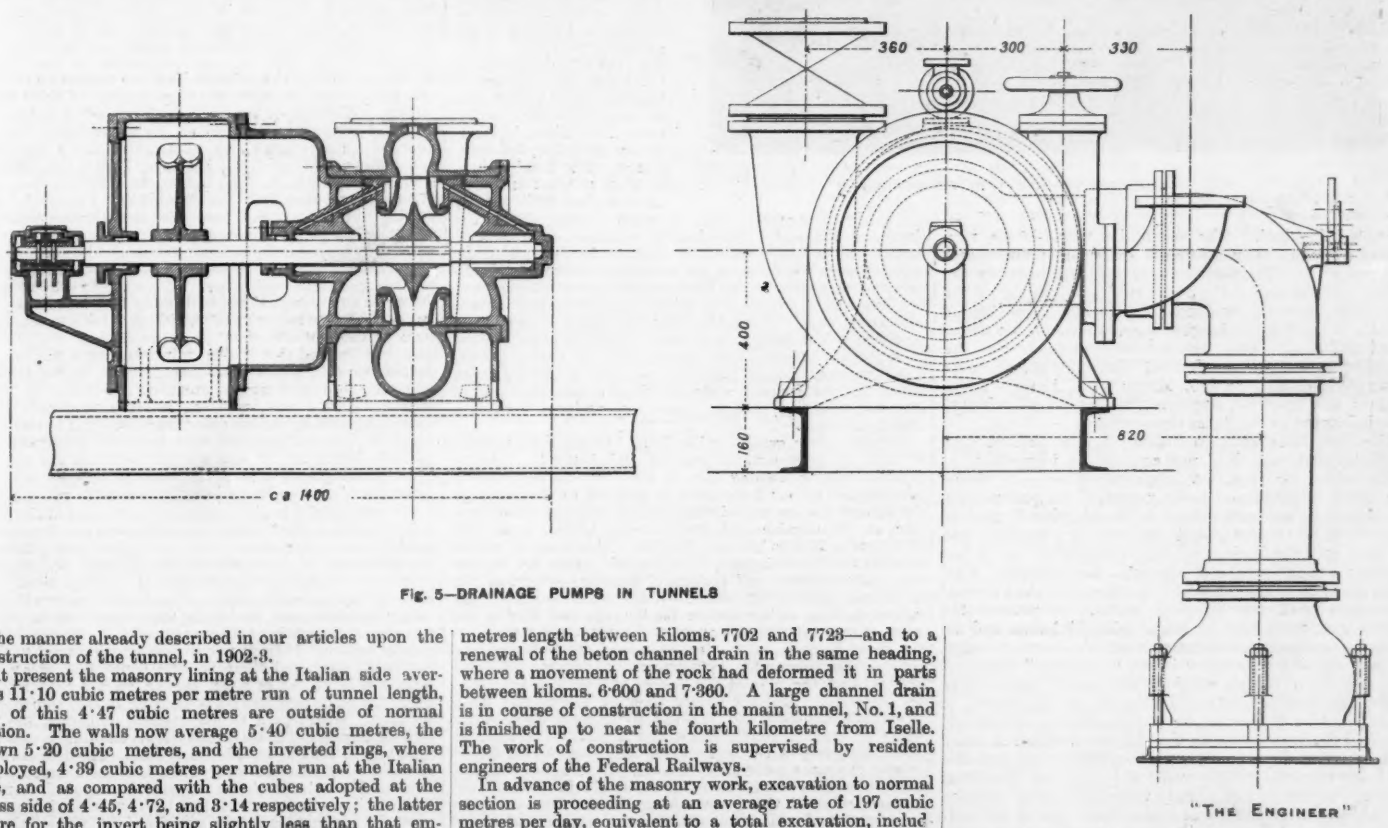


Fig. 5—DRAINAGE PUMPS IN TUNNELS

"THE ENGINEER"

ing power-water to the two drainage pumps still working in the tunnel are now only required to furnish 25 litres per second. These high-pressure pumps, run by hydraulic turbines, are shown in the view, Fig. 4. They are designed to develop a pressure of 40 to 44 atmospheres, say a maximum of 650 lb. per square inch, and to raise 150 litres of water per second—that is, 4½ cubic metres per minute each one. The details of the low-pressure drainage pumps used in the Simplon Tunnel are given in the accompanying drawing, Fig. 5. They are connected to Pelton wheels developing about 60 horse-power. The other centrifugal pumps at work at Brig still supply 75 litres per second of cooling water, as described on page 415, and these will also be available for power services in the advanced headings, as shown on page 489.

The infiltration water—exclusive of the supplies pumped in—has now slightly increased to a total of 198 litres per second, having a temperature at outfall from the tunnel of 26·5 deg. Cent. Where the hot-water drain pipe from the submerged headings discharges into the drain of tunnel No. 2 at kilom. 8·840 the water temperature is now 36·5 deg. This discharge is shown in the flashlight view —Fig. 6—which was made while its temperature was being read by one of the tunnel engineers. On account of the difficulty of traversing the whole length of this narrow and encumbered heading the periodical observations of temperature have recently been reduced to once a month.

At the mid-tunnel station—Swiss workings—the acetylene gas plant is still maintained, although not in regular service. This plant comprises a gasometer, fitted to a truck, about 800 m. of 20 mm. gas pipe, and ten 16 candle-power burners. Oil, and not gas, is otherwise the sole means of illumination that has been employed at both ends of the tunnel.

Ballasting for the permanent way has been begun at the Swiss side, and 4000 cubic metres of foundation ballast have been laid on the right half of the way up to kilom. 8·300, and considerable advance has also been made at Brig, the Swiss end, with riverside embankments and retaining walls, new passenger and goods stations, locomotive-house, and repair shops; and the new rails up to the tunnel entrance the railway gradient of 1 in 40 will require the most powerful locomotives belonging to the Mediterranean Railways of Italy—see Fig. 7—which engines are to be yet further increased in length in order to give more adhesive weight.

FIG. 7—LOCOMOTIVE FOR 1 IN 40 GRADES

are now being laid. The locomotive round-house, now almost complete, is an admirable example of reinforced-concrete work. The partitions, or housings, between the pillars, and the asphalting of the roof and glazing of the roof lights remain to be done. The turntable provided is capable of turning the longest locomotives of the Swiss Bundesbahnen. The locomotives designed for the Simplon section of the Federal Railways system were illustrated upon page 309, March 27th, 1903. These engines are, however, employed besides on all railways now belonging to the Swiss Government.

The line from Brig to Lausanne is at present only single-tracked, and does not convey the impression of being suited for very fast international trains. Basle, the great international railway centre in Switzerland, requires to be connected direct to the Simplon Tunnel, at Brig, by a line better suited for modern travelling, and to this end the boring of the Wildstrübel, or of yet another tunnel proposed through the Bernese Alps, appears to be of the greatest importance for the eventual development of the Simplon traffic. At present the fastest train from Brig to Basle takes 8½ hours, and the more conveniently-timed train takes 10¼ hours, it being, in fact, an all-day journey in an "omnibus" train. A traveller from Zurich would often prefer, rather than make the long detour *viâ* Lausanne, as at present, to cross the Alps, journeying to Goeschenen by the Gotthard line and thence to Brig by the diligence, which is also a full summer day's journey. It seems quite probable that the eventual freight traffic to be secured by a direct line to Basle would be equally valuable to that expected from Geneva and the direct connections yet to be made with Paris; for Basle, while being a great railway centre and not remote from the most industrial parts of Europe, lies but little to the east of a direct line from Brig to Calais, and by this itinerary a new and shorter route through North-East France and through Switzerland would also be possible for the Brindisi mails.

At the Italian side of the tunnel the railway works are very far advanced. The new direct line from Domodossola to Arona is practically completed, the track having been laid, and the thirteen tunnels on the route are now in course of equipment with signals, &c. At Domodossola the imposing international station and Customs offices are but half complete. From this point

OUR MINERAL STATISTICS.

PART III., "Output," of the Mines and Quarries Report for 1903, is now before us, and invites a word or two of comment. On the present occasion, in agreement with our notice of last year, the coal and iron trades, which form an important part of the statistics, will not come up for consideration, limitations of space compelling their exclusion. Although in regard to metalliferous mining generally the report has nothing startling to say in the direction of progress, yet, if we except arsenic, which continues to show a deplorable diminution, there is certainly nothing to indicate that British mining is in the moribund condition which imperfectly informed writers would have us to believe. Copper, gold, lead, tin, zinc, and wolfram all show increased values, while silver mining again finds its place in the report after a lengthy absence. Again, in the case of manganese, though the output in 1903 showed a considerable reduction on the 1902 figures, this is only a temporary set-back. We are, of course, in the present notice, dealing only with 1903, but, if we may be allowed to be a little previous, we may say that the output of manganese ore from Carnarvonshire will show a very considerable increase when the returns for 1904 are got out. Moreover, the ore now being raised is of a higher grade than is indicated by the prefatory remarks to the manganese figures in the report under notice. This suggests a word or two of mild criticism to the effect that in some instances these prefatory remarks, which have done duty often for a number of years, should be edited and brought up to date. For instance, on page 175, under the heading of "Chert and Flint," it is stated that chert is obtained principally from strata of the Carboniferous age in Derbyshire and Flintshire. This represented the state of affairs three or four years ago right enough, but to-day, from Upper Swaledale, in the North Riding, comes a large and increasing amount of this mineral, the returns from Yorkshire in the chert and flint tables having reference entirely to chert. With regard to chert, by the way, the statistics do not give as much information to-day as was formerly the case. In the report for 1888 chert and flint are separately specified, while to-day no such detailed information is given. Certainly, with regard to this mineral, the definitions given in geological text-books vary a good deal, and undoubtedly minister to confusion of mind. For the purposes, however, of the present review, we are considering as chert just that material which is supplied under the name to the Potteries as runners and pavers in the grinding of China stone, &c. On this definition we think that the inspector for the Southern District, who is responsible for the returns from Kent, is incorrect in using the joint headline of "Chert and Flint," as none of what is understood as chert in the pottery trades comes from the South of England. One further reference of a general nature may be made for which also chert will serve as an object lesson. It is quite probable that decreased returns may be registered in the forthcoming years, but one must not jump to any hasty conclusions of a pessimistic nature concerning this. The fact is that the material now being produced in Yorkshire is superior to that from other sources of supply in hardness, and consequently in lasting power, and it may be expected that this will lead to reduced sales, seeing that the demand, after all, is not a particularly large one, and, moreover, does not show any tendency towards a notable increase.

To refer now in greater or less detail to some of the metals, it will be convenient to proceed alphabetically. About arsenic there is nothing new to say. The further decline adumbrated in our last review is testified to eloquently in the figures, the amount of white arsenic obtained by calcination at the Cornish and Devon mines having sunk from 2131 tons in 1902 to 902 tons in 1903. This state of affairs is attributable very largely, if not entirely, to the fall in price due to the discovery and working of deposits of arsenical ores in various parts of the world. With regard to copper, the figures showing an increase in the tonnage and also in the value of over £4000 hardly support the prefatory note as to the rapid decrease in the importance of the industry. Of course, compared with 1863, when the output was over 210,000 tons, the present-day figures of 6867 tons are not at all imposing. Still the figures show an upward and not a downward tendency, and from the development work that is being pursued in North Wales and Yorkshire we shall be much surprised if the returns for the present year do not exhibit the same satisfactory feature. It is noticeable that the increase is contributed to by England, Wales, and Ireland, while if the reports from Wester Ross are not exaggerated, Scotland will shortly be a regular producer of copper ores. Reference to Yorkshire in this respect may occasion some degree of surprise among those unacquainted with the mining history of the county before regular records were kept. A saying to the effect that, in the case of old mines, what the ancients left is not worth seeking, is, no doubt, to a great extent true, but it must also be considered as extremely probable that the "old men," to use a mining term, did not discover everything of value which existed in the setts which they worked. Turning to iron ore, we find that a slight increase is reported over 1902, though the total of 13 million odd tons does not compare favourably with the 18 million odd in 1882. Confirmation is somewhat lacking of the reported new discoveries by the electrical ore finder in the Furness district, and no other new sources come up for notice. With regard to imports, Spain, as of old, easily heads the list, though with a decreased amount compared with 1902. Russia, Algeria, France, Sweden, and Norway all show increased exports of ore to Great Britain. The figures credited to Norway seem to require a little explanation. There is a rise from 624 tons in 1902 to 123,611 tons in 1903, but presumably the bulk of this is Swedish ore sent from Narvik, as the total production of Norway does not yet approach anything like the above figure. Of course, when the Dunderland Company gets to work, things will be different. With regard to lead mining, an increased amount of dressed galena is reported to the extent of 1961 tons. This increase must be credited almost entirely to the two principal mines in this country, Halkyn in Flintshire, and Mill Close in Derbyshire; both of these have largely increased their output, though it is noticeable that most of the other lead mining centres show declines. Much of the ore at present being worked at Mill Close is phenomenally rich, requiring no dressing before being smelted. In the North of England things have not been very prosperous; the yield of lead has fallen off in Weardale, and with the pulling out of the rails in the Arkendale mine in Swaledale, it may be considered that the last stroke of misfortune has overtaken this once prosperous district. On the other hand, the decreased output from Cumberland must be attributed, not so much to lack of ore, but to the fact that zinc mining is being more actively prosecuted, the lead being kept in reserve. Again, in Teesdale the development work which is being actively carried on at the Wiregill Deep mine promises to yield results of considerable value.

Manganese has already had a reference, and we pass on to nickel, which occupies a couple of lines in the report. The Palnure United Exploring Company, we may say, is now quite defunct; the work which was carried on in Kirkcudbrightshire does not seem to have been designed or carried out on advisable lines, and the amount of capital available was obviously insufficient for the nature of the undertaking. The ore is kupfernickel, or arsenide of nickel, occurring in patches in rocks of Lower Silurian age. Although, of course, the demand for nickel in connection with armour plate has largely increased in late years, the deposits discovered in Ontario and New Caledonia have pretty well preserved the equilibrium between supply and demand. Moreover, the ores from these districts being non-arsenical, offer much more attraction to the smelter than do the arsenides occurring in other countries.

Tin, the mainstay of Cornish mining, comes next on our list. Thanks to the upward movement in price, the value of the black tin obtained in 1903 exceeded that of 1902, the figures being £532,450 in the former year and £513,872 for the latter. The output of ore, however, showed a decrease of 178 tons. It is, unfortunately, the case that in the principal mines the yield of black tin to the ton of tin stuff has shown a falling off; so serious a diminution, in fact, that were it not for the improved methods of working now in use the very existence of the mines would be seriously imperilled. Against the foregoing unsatisfactory remark, however, it must be remembered that 1903 was an exceedingly wet year, much extra pumping being required over normal seasons; further, some quite rich yields of ore have recently been reported from more than one district in Cornwall, from which one may hazard the opinion that a revival in the prospects of the industry is to be looked for in the future, if, indeed, it is not imminent. Considerable success seems to have attended the work of the Clitters United mine at Gunnislake, and this example of what can be done by the adoption of up-to-date appliances should not be lost on the directorates of other mining companies in the Duchy, though, as a class, Cornishmen have the reputation of being extremely averse to altering the procedure of their grandfathers. Wolfram, or tungsten, is closely allied to tin in its mode of occurrence, and comes up conveniently here for mention. The output has fluctuated greatly in recent years; thus, 1885 produced 374 tons, 1899 ½ ton, 1898 326 tons, and 1902 9 tons. The figures for 1903, however, show 272 tons, and now that the demand is so great for steel making purposes, it can hardly be that Cornish enterprise will allow the production to again proceed in such an erratic manner as is shown in the above figures. The main point of interest about the 1903 figures is that the production is due to the successful application of the Wetherill magnetic separator to a complex ore containing tin, iron oxide, and wolfram, the component parts of which fetch a much higher price at the smelters than does the original ore. It can hardly be doubted that if other mines having a similar complex ore were to follow suit, their present modest profits—supposing that there are any profits at all—would be greatly enhanced. Of course, wolfram is being produced on an increasing scale in various other countries, and is also to be found in Cornwall unmixed with tin; but where two such valuable bodies as tin and wolfram occur in the same ore mass, their separation at a low working cost seems to offer particular attraction as a mining proposition.

We come finally to zinc, which, as in the case of tin, shows a slightly diminished output, but a higher value as a natural result of the higher prices ruling for spelter during the year. The Nenthead mine in Cumberland still holds first rank as a producer, followed by the Minera of Denbighshire. The mines of Cardiganshire show an increased output which will hardly be maintained, seeing the sensational sale in April of this year of the whole of the new plant at the Frongoch mine. A large amount of blende was thrown on the dumps in Wales in bygone days, and there is little doubt that this will be recovered in course of time, though we are very sceptical about the plans proposed for converting it into zinc oxide on the spot. With regard to non-metallic minerals, the most striking figures are those for fluor spar, showing a rise from 3708 tons in 1902 to 10,497 tons in 1903. The demand which has arisen is from the North of England as a metallurgical flux, and the bulk of the increase is supplied from the Durham lead mines. Gold has been reserved for mention until the last, but space only permits of the remark that the increased yield shown by the two principal Merionethshire mines in 1902 will assuredly be maintained, as recent returns from the mines have been of a highly satisfactory nature, so much so, indeed, as fully to warrant the attention of speculators.

ASSOCIATION OF RAILWAY LOCOMOTIVE ENGINEERS OF GREAT BRITAIN AND IRELAND.—At a meeting held at the Midland Grand Hotel, St. Pancras, on the 25th November last, Mr. James Holden, the locomotive engineer of the Great Eastern Railway, was unanimously elected president of the Association for the ensuing year.

RAILWAY MATTERS.

THE Edinburgh and District Tramways Company has appointed Mr. Harris, at present assistant engineer in their service, to succeed Mr. W. M. Colam as chief.

IT is announced that the Great Western Railway Company is having two more four-cylinder compound engines built on the De Glehn system, considerably larger and more powerful than in France.

THROUGHOUT the recent heavy snowfall the electrified train service on the North-Eastern Railway Company's suburban lines at Newcastle was maintained in full operation without any interruption or the slightest difficulty of any kind.

IT has been decided to extend the Lagos Railway from Ibadan to Oshogbo, a distance of 72 miles. Mr. W. Wotherspoon, engineer in charge of the survey of the Lagos Extension Railway, has left this country to survey the country and stake out the line.

THE length of the steam railways in the United States on December 31st, 1903, was 207,603·53 miles, a net increase of 4595 miles during the year. The total liabilities of the companies owning these railways are given at £2,857,851,991, and the assets at £2,972,402,108.

ONE of the great railway companies in the United States of America is preparing to substitute oil for coal in 780 locomotive engines on a system comprising upward of 9000 miles of road. The cost to the company per horse-power with oil is said to be only a third of the cost of coal.

LOCOMOTIVES exported from the United States to Japan in the nine months ending with September, 1904, were fifty-eight in number, against eighteen in the corresponding period of 1903, and twelve in the corresponding period of 1902. The value of these exports for the nine months of 1904 was £88,420, as compared with £35,642 in the corresponding months of 1903, and £22,230 in 1902.

ON Saturday, December 3rd, the Metropolitan Electric Tramways, Limited, opened for public traffic another extension of their electric tramways. The new line, which is about five miles long and has double track throughout, runs from Cricklewood to Edgware. The electricity for working this line is supplied from the large generating station of the North Metropolitan Electric Power Supply Company at Willesden.

IN addition to its ordinary train service the Cambrian Railway Company, alive to the needs of the times, has begun from 1st December the running of a number of short trains. The service will include two extra trains from Whitchurch to Oswestry, two from Oswestry to Llangyllin, two from Welshpool to Newtown, and one from Machynlleth to Aberystwith. The same number of trains will run in the opposite direction, while a similar service will be run on the coast and Mid-Wales sections.

THE total revenue earnings of the South Indian Railway in the half-year ended June 30th amounted to Rs. 61,70,491, or an increase of Rs. 57,527 compared with 1903. Working expenses came to Rs. 26,96,575, or an increase of Rs. 4,05,165, and net earnings were Rs. 34,73,916, or a decrease of Rs. 3,53,431. The company's share of surplus profits was Rs. 3,47,070, which allows a dividend of 2½ per cent. out of this fund, making, with the guaranteed interest, a total distribution at the rate of 7½ per cent. per annum. The sum of £16,502 is carried forward.

APPLICATION is about to be made to the Light Railway Commissioners for power to construct a light railway to connect Warrington and Knutsford. The line is to be divided into three sections. The first, about nine miles and three-quarters in length, will start near Latchford swing bridge, on the Ship Canal and, running along Knutsford-road, will pass through Thelwall, Lymm, High Legh, Mere, Tabley Superior, to Canute-square, Knutsford. From the square a continuing line will run to, and terminate at, the entrance to the Cheshire lines station, Knutsford. Another short line will run to the goods yards of the same station.

ON the Prussian State Railways a number of express trains are about to be lighted electrically, and twenty-two turbo-dynamos of the de Laval type have been ordered. The set in each case is mounted on top of the locomotive boiler, and the turbine develops some 20 horse-power at 20,000 revolutions per minute. It is directly coupled to a continuous-current dynamo, which is capable of supplying 180 ampères at voltages from 68 to 90 volts. Each carriage of the train is provided with a 32-cell storage battery of a capacity of 76 ampère hours. The lamps are designed for 48 volts; the difference in voltage is taken up by iron resistances.

A FURTHER extension of the Cape to Cairo Railway to a point 350 miles north of the Zambesi has just been decided upon. Sir Charles Metcalfe, consulting engineer of the railway, who is now superintending the work on the Zambesi, reports that rapid progress is being made with the line to the north of Victoria Falls, and it is expected that rail-head will be at Kalomo, the administrative centre of North-West Rhodesia—Barotseland—early next year. From Kalomo, which is 100 miles north of the Zambesi, in pursuance of the decision reached, work will be continued in a north-east direction to Broken Hill, a point 250 miles beyond Kalomo.

WHAT was claimed as a new system of motor tramcar, worked by a petrol engine, and a new patent noiseless gearing, which can be adapted for working on any gauge, and practically on any gradient, was described by Mr. Alexander Clark, A.M. Inst. C.E., at a meeting of the Royal Scottish Society of Arts in Edinburgh on 28th ult. The paper was entitled "The Tram and Road Car of the Future," and, comparing the cost of the present electric tramway system with that of the proposed motor tramways, it was pointed out that the latter worked out from 3d. to 5d. per mile less than the former, owing, in great measure, to the enormous cost of electric installations and generating stations.

IT must be abundantly clear to the most superficial observer that either the Cape railways are grossly mismanaged, or that the hope of any permanent expansion of trade in South Africa must be abandoned. South African trade is being strangled by the inland railway charges. One thousand tons of cement for Johannesburg, the sea freight on which from England to Cape Town by steamer would be £625, would be charged no less than £7900 for transmission by rail to Johannesburg, a distance of 1014 miles, against over 6000 miles of sea voyage, says the "Look Out Man" in *Fairplay*. The same system of over-charge on the necessaries of life, all of which have to be imported, obtains throughout, and a similar disparity between the sea and land freights.

THE annual report of the Government Railways of Western Australia has just been issued. It discloses that 1755 miles are open for traffic, and 63 miles under construction, which will be opened for traffic during the current year. The capital invested amounts to £8,955,929, of which no less a sum than £482,303 has been contributed out of revenue. In this respect Western Australia stands alone among the Australian States in her use of current revenue for capital expenditure in railway construction. After debiting the railway with interest on the whole of this outlay, there is a sum of £111,784 net profit on the year's working. No other State has such a record. The gross expenditure for the year has been £1,179,624, and the gross earnings amounted to £1,588,084, and one of the most gratifying features has been the reduction of working expense, notwithstanding large increases in the wages bill. It will be noticed that not only have the railways paid interest and sinking fund on all the capital invested, but they have also provided a handsome contribution to the general revenue of the State.

NOTES AND MEMORANDA.

IN America there were 7222 manufacturers and 627,047 domestic consumers supplied with natural gas for light, heat, and power in 1903.

THE civil list of New York city contains the names of one engineer whose salary is £3000, one at £2400, two at £2000, one at £1600, four at £1500, two at £1400, five at £1200, six at £1000, four at £900, nineteen at £800, twelve at £700, and twenty-seven at £600: there being 117 getting £500 or more.

A REFRACTORY fire-brick, suitable for certain purposes, is made by cementing quartz sand with milk of magnesia, drying and carefully burning. According to the *Engineering and Mining Journal*, the brick is very infusible, and its coefficiency of expansion on heating is not too high, which gives it additional value in construction.

AN interesting hydraulic power plant has recently been started in Southern California. The head employed is 1960ft., which is obtained at the bottom of a pipe line something over 8000ft. in total length. This gives an effective pressure, after making due allowance for friction loss, of considerably over 1900ft. head, or 825 lb. per square inch.

AN American firm making twist drills recently received an order for twist drills made of a certain high-speed steel, which were duly shipped. Soon there was a complaint from the customer, who claimed that he could "get no results from them." "They were no better than common drills," &c. Upon investigation it was found that the customer was using the drills in a hand-driven ratchet!

SOME remarkable recalescent alloys of copper and antimony have been recently prepared by a Russian named Baikoff. The violet alloy $SbCu_2$ melts and decomposes at 516 deg. Cent., forming $SbCu_3$, which melts at 681 deg. Cent. The alloy $SbCu_3$ exists in two modifications, the α form, stable only at temperatures below 407 deg. Cent., and the β form, stable only at high temperatures. This fact was confirmed by thermal and micrographic studies.

SOME remarkable engineering literature sometimes finds its way into the non-technical Press of this country, but the description of a new four-cylinder balanced Baldwin compound locomotive which was published some time ago in an American daily shows abnormal powers of imagination on the part of the writer, who wrote that, not only has the locomotive four cylinders, but "by working on the crank motion steam is generated all around, and continuous power is thus kept up, with a saving of 25 per cent. in fuel."

IT had been considered that 10 or 12 per cent. would be the maximum of phosphorus which could be secured in combination with iron, but, according to an American paper, a firm of analytical chemists of Nashville have tested four casts made at this furnace, which show 18, 19·72, 18·76, and 18·77 per cent. Subsequent casts tested by the chemist at the furnace run as high as 21·81 per cent. The statement is made that Mr. Gray has demonstrated the possibility of combining with pig iron whatever percentage of phosphorus may be demanded.

A REMARKABLE test of tool steel was reported some time ago in the *American Machinist*. The test was made on an 84in. lathe, and a cut 1¾in. deep was taken with a ⅜in. feed, at a speed of about 50ft. per minute, with high carbon steel. A correspondent to the same paper points out that with chips of ordinary proportions the power required to remove a cubic inch of steel per minute varies inversely as the feed, and for big feeds it may be comparatively low. But even so, assuming a coefficient of 33, which surely is low for high carbon steel, the power demand would be estimated at 440 × ·33 = 145 horse-power, which, he remarks, is surely a good deal to be absorbed at one tool.

THE General Post-office engineers have made rapid progress with the extension of the underground telephone system of London. The cables are in working order as far as Hampstead in the north, where a new exchange has been opened, and the work is being pushed forward a good deal further in that direction. A new exchange has also been opened at Croydon in the south; and westward the system has been extended to Kingston-on-Thames, but in the east not beyond the city boundaries. Eleven telephone exchanges have been opened up to date, and call offices innumerable. At the end of November, 1903, there were 13,500 subscribers, and now there are 21,400. The system will ultimately cover an area of 640 square miles.

IN a steam turbine or water turbine the theoretical condition of maximum efficiency, and therefore of maximum economy, exists when the jet of working fluid moves with a velocity equal to about twice that of the vane against which it acts. Steam expanding from a pressure of 150 lb per square inch into the atmosphere is capable of imparting to itself a velocity of 2950ft. per second; if expanded from the same initial pressure into a vacuum the resultant velocity is 4010ft. per second. The velocity of water discharged from a nozzle under a head of 350ft.—giving the same pressure as above—is only 150ft. per second. These figures, says the *Iron Age*, illustrate the different conditions existing in steam turbines and water turbines.

SHIPS in motion in relatively shallow water have a greater draught than when at rest under the same conditions of loading. This interesting and important fact has been developed by a recent investigation in New York Harbour, says the *Iron Age*. It has long been recognised that the stern of a vessel in rapid motion has a tendency to settle, but it now appears that the entire ship takes what is known as a "squat" under such conditions. The importance of the fact may be realised when it is stated that a ship supposed to be drawing 29ft. of water, passing over a bar where a depth of 30ft. exists, will almost invariably strike bottom, even though her speed be relatively slow. The magnitude of the "squat" has in some cases been found to exceed 4ft.

THE utilisation of electric power in Italy has grown apace since 1890. At that time the only important plants were situated at Milan, Rome, Genoa, Turin, and Naples. It is improbable that the total electric motive force available in Italy in that year exceeded 20,000 horse-power. To-day electricity in Italy provides a total motive force of over 200,000 horse-power. Milan alone disposes of 20,000 horse-power, and the large new hydro-electric station at Vizzola near Milan distributes 18,000 horse-power to various points in the provinces of Milan and Como. The central station at Genoa generates and distributes over 8000, and those of Rome and Naples over 10,000 horse-power respectively. The new plant at Cellina will shortly be in a position to distribute a motive force of about 18,000 horse-power.

AN article by Mr. J. H. Hallberg, which appeared some time ago in the *American Electrician*, on street lighting by small current enclosed arc lamps, states that both direct and alternating lamps, taking 3 or 4 ampères, are uneconomical if worked in parallel off the ordinary lighting mains at 118 volts. Moreover, the arrangements of automatic switches for lighting them, or of switches worked by special wires from the central station, are likely to be unsatisfactory. On the other hand, when such lamps are worked in series on special high-tension mains, a much higher efficiency is obtained, amounting to about 94 per cent. at the lamp terminals. The direct-current series system is considered, on the whole, to be the best, owing to the fact that its light is white as compared with the alternate-current lamp, which gives a large proportion of violet rays.

MISCELLANEA.

THE Thames Conservancy have decided to construct a new lock at Molesey at a cost of £10,750.

THE London County Council is about to advertise for tenders for the supply of another motor steam fire-engine.

THE Saxmundham Urban District Council have decided in favour of a sewerage scheme at an estimated cost of about £7000.

ACCORDING to the *Figaro* the idea of organising a new Paris Exhibition is said to be on the point of taking the form of an official project.

THE last block of the eastern breakwater of the Admiralty harbour at Dover was laid on Friday last. The southern breakwater is progressing rapidly.

THE sum of £17,800 has been taken in the French Budget for 1904 for the study of a system of water supply for Cotonou in Dahomey, and at the same time of a drainage system for that town.

AN inquiry has been held into the application of the Barnsley Corporation for sanction to borrow £60,011 for the purpose of completing the Midhope Reservoir, upon which £298,601 has been already expended.

NEW YORK is about to connect its eastern part with its western by means of two underground moving platforms, one of which will travel at the rate of four English miles an hour and the other at the rate of nine. The two platforms are to be capable of carrying 47,000 persons an hour.

AT this week's meeting of the London County Council, in reply to a question upon the report of the Bridges Committee, Mr. Strauss, chairman of the Committee, said that the progress in the construction of the new Vauxhall Bridge was very slow indeed, but the work done so far was of a most satisfactory character, and no complaints had been received.

THE Automobile Club proposes to hold a race for tourist cars next year, probably in the Isle of Man during the month of September. The allowance of petrol will be determined by the Club. The weight of the chassis must be not less than 1300 lb. nor more than 1600 lb., and the load carried by the chassis not less than 950 lb. The body is to be of the ordinary tourist type.

A SERIOUS accident occurred on Wednesday morning on the Great Eastern Railway between Isleham and Mildenhall. While workmen were repairing a bridge, part of the structure had been removed, and the other portion fell, throwing the workmen about 16ft. on to the road. Three of them were so badly injured as to necessitate their removal to Addenbrooke's Hospital, Cambridge.

THE sum of £111,000 has been subscribed towards £170,000 required to complete the new building scheme in connection with Sheffield University College, which leaves £59,000 to raise before the charter can come into force. Notices have been deposited with all the local authorities in connection with the North Lincolnshire Light Railway. The estimated total cost is £586,000.

THE shareholders in the Torquay and District Motor Omnibus Company, Limited, are to be congratulated on the first year's operations, which have resulted in a dividend of 7½ per cent. The omnibuses are all of the Chelmsford pattern. This, we believe, is the first company operating only motor omnibuses which has been able to declare a dividend and complete twelve months' working.

AT this week's meeting of the Bournemouth Town Council a motion to the effect that the Corporation electric tramways should run on Sundays was defeated by a large majority, only four votes being recorded in favour. The Council also decided not to light the main thoroughfares by electric light on Sundays, as this would entail additional Sunday labour at the Corporation generating station, but to continue to light the streets with gas on Sundays.

THE fleet of nine steamers which the Belgian Government maintains for the cross-Channel service is to be increased by the addition of a turbine steamer with a speed of 23 knots. It is said that Belgium intends to replace gradually all the old steamers of a speed of 19 knots by turbine steamers similar to that to be introduced shortly. The new steamer is to be fitted up splendidly. Among other conveniences it will carry a Marconi apparatus for the use of voyagers, and also a powerful searchlight on the bridge.

AT a meeting of the Royal Agricultural Society held in London on Wednesday the question of holding the next year's show was discussed, and it was decided "that a final decision as to the show in 1905 be postponed until a meeting of the Council to be held in the second week of January, 1905, in the hope that further sums by way of subscriptions or guarantees will meanwhile be forthcoming from members, exhibitors, and others, which, in the opinion of the Council, will be sufficient to warrant the Society in organising a show for 1905 without further loss to its general funds." Of the sum of £10,000, for which subscriptions were asked, only £5000 has up to now been promised.

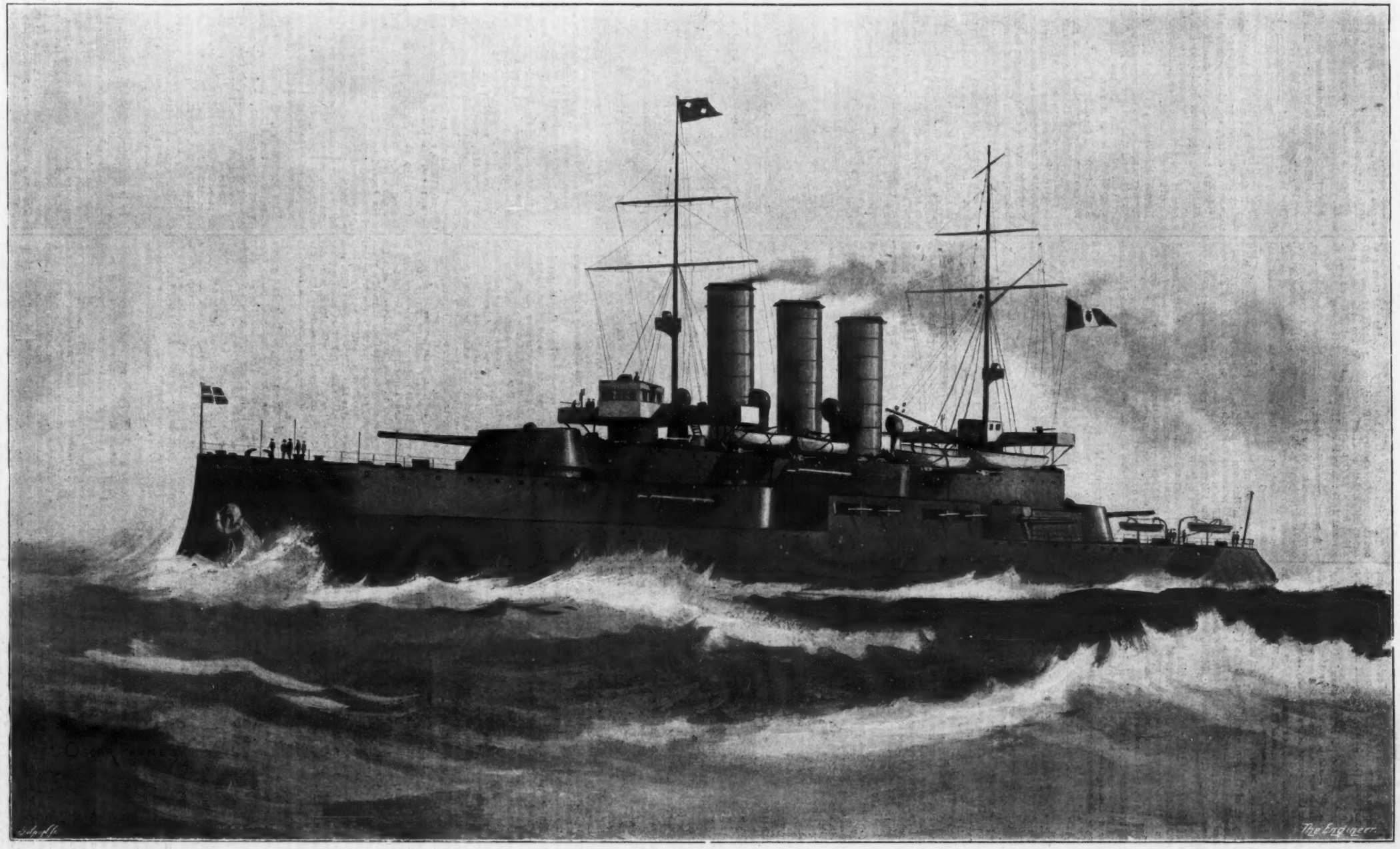
OWING to the decayed and dangerous state of the existing pier at Salen, on the island of Mull, West Highlands, a new pier is at present under construction there, from the designs of Mr. James Deas, C.E., Glasgow. It consists of a substructure of concrete carrying a pier head of open timber work approached by a wooden gangway. The new pier will provide a depth of water sufficient to permit the calling at all states of the tide of the largest class coasting steamers frequenting the West of Scotland. Diving operations, necessary to the construction of the concrete substructure and other constructional work, are in active progress, and everything points to its due completion about the 30th April next. The contractors are George Halliday (Limited), Rothesay.

THE second annual reliability trials for motor boats under the auspices of the Automobile Club is announced to take place next year, and will extend over two days. The trials will probably be held in Southampton water. There will be six classes, as provided by the Marine Motor Association regulations, with beam and freeboard restrictions:—(1) Yachts' dinghies (clench built) not exceeding 15ft. over all; (2) yachts' launches (clench or carvel) not exceeding 20ft. over all; (3) yachts' launches (clench or carvel) not exceeding 25ft. over all; (4) yachts' launches (clench or carvel) not exceeding 30ft. over all; (5) unrestricted vessels of any description propelled by internal-combustion engines, and not exceeding 25ft. over all; (6) unrestricted vessels of any description propelled by internal-combustion engines, and exceeding 25ft. over all.

IT is announced that the American Car and Foundry Company has acquired a site in Trafford Park, Manchester, for the purpose of erecting large works for the manufacture of railway wagons and carriages. This company already possesses fifteen large works in the United States, and its daily "output" is more than three hundred wagons and carriages. It has just undertaken a contract for the supply of the railway carriages for the Baker-street and Waterloo Underground Railway in London. All these carriages will be built and finished at the new establishment in Trafford Park. The only portion of the work which will be imported will be the steel work, which will be received in a finished state. The remainder of the work will be done in England, and will necessitate the employment of local labour to the extent of £15,000 to £20,000.

ITALIAN BATTLESHIP VITTORIO EMANUELE III.

(*For description see page 575*)



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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Ten o'clock on Tuesday morning in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

G. B. (Dudley).—The Metropolitan Fire Brigade uses, we believe, the standard screw coupling.

HIBERNIAN.—See "Chimney Design and Theory," by W. W. Christie, published by E. and F. N. Spon.

J. T. (Lewisham).—We cannot tell whether your risk is "doubly hazardous" or not; you must leave that to the insurance company to settle. The premium would probably be 5s. per cent.

O. J. S.—The prices are quoted weekly in our "Notes from Scotland." The Board of Trade could probably refer you to some of their publications giving averages. The secretary of the Chamber of Commerce, 7, West George-street, Glasgow might also be able to help you.

A. S. B.—You could get what you want from J. W. Titt, Warminster. Wilts or R. Worner and Co., 97, Queen Victoria-street. You would do well to see the account of all the mills shown, which appeared in our issue of May 1st, 1903. All mechanical force pumps will work quite well under water.

J. T. D. (Madrid).—Take the cap off and clean the bearing thoroughly of oil. Cut out the bottom of the oil-box in the cap so as to leave a slot instead of the oil holes. Procure some blacklead that used for cleaning stoves will do, and beat it and tallow into a paste and fill the oil-box with this. We have found this answer admirably with a heavy flywheel bearing which always ran hot with oil. No oil must be allowed in combination with the blacklead and tallow.

ERRATUM.

Short Notice, page 559 of last issue, for "The Practical Engineer's Pocket-book," read "The Practical Engineer" Electrical Pocket-book and Diary 1905; and for "Simpkin, Marshall and Co." in the notice of the "Practical Engineer" Pocket-book, 1905, read "The Technical Publishing Company, Limited, Manchester."

MEETINGS NEXT WEEK

THE INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' ASSOCIATION.—Monday, December 12th, at 8 p.m. Paper, "Gas Engine Testing," by MR. A. C. HESS.

INSTITUTE OF MARINE ENGINEERS.—Monday, December 12th, at 8 p.m., at 58 Romford-road, Stratford, E. Paper, "Fuel Economy by Insulation," by MR. LYDDON.

LIVERPOOL ENGINEERING SOCIETY.—Wednesday, December 14th, at 8 p.m., at the Royal Institution, Colquitt-street. Ordinary meeting. Paper, "Heavy Motor Vehicles" by MR. THOMAS MOLYNEUX.

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—Wednesday, December 14th, at 7.30 p.m., at the St. Bride Foundation Institute, Bride-lane, Fleet-street. Paper, "Oil Engines," by Geo. H. Herbert, M.I. Mech. E.

RUGBY ENGINEERING SOCIETY.—Thursday, December 15th, at 8 p.m., at the Benn Buildings, High-street. Ordinary general meeting. Discussion. "Premium System *v.* Piece-work System," by Messrs. G. T. Wood and J. P. S. Glover.

THE INSTITUTION OF CIVIL ENGINEERS: ASSOCIATION OF YORKSHIRE STUDENTS.—Thursday, December 15th. Ordinary meeting. Paper, "Notes on Construction and Erection of Steel Work," by Mr. B. J. Rudyard, A.M.I.C.E.

SOCIETY OF ARTS.—Monday, December 12th, at 8 p.m. Cantor lectures: III. "Musical Wind Instruments." by David James Blaikley. Wednesday, December 14th, at 8 p.m. Ordinary meeting. Paper, "The Patent Laws," Chas. D. Abel.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.—Wednesday, December 14th, at 7.30 p.m., in the Physics Theatre of the University, Edmund-street. Paper, "Stand-by Charges and Motor Load Development," by A. M. Taylor.

THE INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW SECTION.—Tuesday, December 13th, at 8 p.m., at the Institution of Engineers and Shipbuilders in Scotland, 207, Bath-street, Glasgow. Ordinary general meeting. Paper, "Armature Reaction in Alternators," by James B. Henderson, B.Sc., and John S. Nicholson, B.Sc.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, December 15th, at 8 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Ordinary general meeting. Discussion on Mr. Searle's paper "Studies in Magnetic Testing." Paper, "The Combination of Dust Destructors and Electricity Works Economically Considered," by W. P. Adams.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, December 16th, at 8 p.m., at the Institution House, Storey's-gate, St. James's Park. Papers: "Heat Treatment Experiments with Chrome-Vanadium Steel," by Capt. H. Riall Sankey, of Rugby, and Mr. J. Kent-Smith, of Queensferry, Flintshire. "Impact Tests on the Wrought Steels of Commerce," by Messrs. Seaton and Jude.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 13th, at 8 p.m. Ordinary meeting. Discussion, "On the Construction of a Concrete Railway Viaduct," by Arthur Wood-Hill, Assoc. M. Inst. C.E., and Edward Davy Pain, B.A., Stud. Inst. C.E. Friday, December 16th, at 8 p.m. Students' meeting. Paper, "Folkestone Harbour, Cylinder Sinking at the Root of the Old Pier," by R. H. Lee Pennell, Stud. Inst. C.E.

THE INSTITUTION OF MINING AND METALLURGY.—Thursday, December 15th, at 8 p.m., at the Rooms of the Geological Society, Burlington House, Piccadilly, W. Ordinary meeting. Papers to be discussed:—"The Dust in the Air and the Gases from Explosives in a Cornish Mine (Dolcoath), and the Efficacy of Methods of Dealing with them," by R. Arthur Thomas and W. P. O. Macqueen. "The Permanganate Chlorination Process at Bethanga," by E. F. Harris. "St. David's Gold Mine, North Wales," by L. H. L. Huddart. "A New Slag Car," by B. H. Bennetts and L. J. W. Jones.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Saturday, December 10th, at 2 p.m., in the Wood Memorial Hall, Newcastle-upon-Tyne. Papers: "The Action, Influence, and Control of the Roof in Longwall Workings," by Mr. H. W. G. Halbaum. "The Miners' Worm Disease as seen in Westphalian and Hungarian Collieries," by Dr. Thomas Oliver. "The Re-tubing of the Middle Pit, Murton Colliery, 1903." by Mr. W. O. Wood. "A Method of Packing Excavations in Coal Seams by Means of Water." by Mr. Edward Otto Forster Brown. "Notes on Safety Lamp Oils," by Dr. George Percy Lishman.

THE ENGINEER.

DECEMBER 9, 1904.

RAILWAY ACCIDENTS.

Two years ago attention was called, in the technical Press of the country, to the enormous number of so-called "accidents" which occurred on the railways of the United States. These were accounted for, it was argued, by the rush of traffic attendant on a time of great commercial prosperity. New hands were employed of necessity, and men without the requisite teaching were put into responsible positions. The Inter-State Commerce Commission, however, heard evidence and obtained information. A report has just been published. From it we learn that last year 3787 passengers and servants were killed and 51,343 were injured in train accidents. In the previous year 3564 were killed and 45,977 injured, and in 1902 2819 were killed and 39,800 more or less severely injured. This is an increase in two years of nearly 1000, or 34 per cent., in the number of killed, and over 11,500, or 29 per cent., in the number of injured. There are in the United States about 250,000 miles of railway, or ten times as much as in this country; but the density of the traffic, the number of trains run and of passengers carried, places this country more nearly on a level with the United States than appears at first sight to be possible. The accidents which occur with us are few and far between, and a comparison of the type of accidents peculiar to the two countries is full of interest. It is not necessary to go into very minute classification; the figures have been published over and over again. It will be enough to say here that in 1902 out of 11,880,000 passengers only six were killed. The worst accidents on British railways are derailments. We never hear of a train going through a bridge. Collisions are due to fogs, for the most part, and, secondly, to mistakes made by drivers or signalmen. Individuals are run over, and shunters are caught under trains or between buffers. In the United States the worst accidents are due to the failure of bridges or trestles, collisions, and the running over of individuals at level crossings. Simple derailments are not exceptionally numerous. We may say, therefore, that in the United States material plays a much larger part than it does in this country; and the disasters which are brought about by personal errors are largely the result of systems of working which are radically defective. Thus, in the United States there is an enormous single line mileage. Roads of this kind can only be worked safely by inflexibly observing the rule that there shall be only one train staff to each section, and that no train shall be permitted to run without this staff. There is, besides, the ticket system, which permits two trains to follow one another on the same section. But it is used rarely and with extreme precaution, and carefully guarded by the use of the telegraph and block signalling. In the United States, with a mileage of single line vastly greater than ours, the staff system is not favoured, and the running of the trains is carried out by the train despatcher. A mistake made by him is, for the most part, irreparable. The system is a bad survival of methods which worked very well indeed when trains were few and slow. Those who would still uphold it have to face the fact that in no other country on earth is there anything like the number of collisions of all kinds that take place in the United States. But this is, of course, only one source of disaster; there are a dozen others. With only one fact, however, concerning them need we concern ourselves just now. It is that if the people of the United States were resolved that railway travelling should be made safe, it would be made safe. There is nothing inherent in the country or the climate, or the conditions of working, to prevent this. Nothing stops the way but the lethargic indifference of the public; and it is a curious and suggestive fact that the terrible slaughter to which the New York Press is now calling attention takes place in a country in which originated the continuous automatic brake, automatic coupling, and some of the most perfect and beautiful signal appliances ever devised. In one respect it is certain that the mechanism of railway traffic is not to blame, the fault lies with the men who use, or misuse it.

At the other side of the Atlantic some of our contemporaries, casting about for explanations of the dreadful increase in the number of catastrophes, attribute it to the augmented speeds and weight of trains. The explanation given is not precise in its terms, or very clear in its enunciation. It appears, however, that bridges and trestles and permanent way are no longer able to carry the locomotives and rolling stock; and we are reminded that the railway companies are unable to bear the financial stress of renewing structures which have outlived their time. Keeping in mind as we do the enormous sums which appear to be available for constructing extensions and new lines, it seems that, not the want of financial power, but the want of will must be held responsible for much that is reprehensible in the conduct of traffic in the United States.

After allowance has been made for all other elements of danger, one remains for consideration which is about as commonly met with in this country as at the other side of the Atlantic. We refer to what has been not inaptly called "temporary mental aberration." The *Scientific American*, writing recently, and with just severity, on the

management of traffic in the United States, says:—"It is difficult to explain the apparent increase in carelessness or absent-mindedness among employés, an increase which is very largely responsible for the growing list of fatalities. Orders apparently are read, understood, and by some curious mental aberration are entirely disregarded. This has been particularly true on single-track railroads. Many recent accidents have been due to trainmen failing to wait at the designated station for a train coming in the opposite direction. In one notorious case, the engineer and conductor were old employés who had been running that particular train carefully and successfully for many years."

The most curious thing about these errors is that not one man but two will fall into them. In this country we constantly find that when a driver has made a mistake about signals, the fireman has not called his attention to the fact. A fruitful source of collision in England is the forgetting by the signalman of a light engine standing on the road. Two men in the same box will both make the same mistake at the same time. Fortunately, the whole theory of railway working is based on the assumption that mistakes may be made unless mechanical precautions are taken to prevent them. The interlocking of points and signals would be wholly unnecessary if signalmen were perfect.

The immunity which we enjoy in this country from accidents is due to ourselves—that is to say, the travelling public will not put up with the destruction of life, limb, and property brought about by avoidable accidents. Until the inhabitants of the United States act energetically from similar motives the slaughter will continue. It is useless to denounce the single-track system and to hold it responsible for the annual killing and maiming of thousands of innocent people. The single line can be worked just as safely as the double line if due precautions are taken. With the train staff, or on crowded roads the electric tablet system, it is next to impossible for a collision to occur. In this country the railway companies grumble at the severity of the precautions which the Board of Trade insist on being taken to secure safety. But the companies are really largely the gainers. Juries never spare them, and the price paid for compensation would, in the long run, be much greater than the outlay rendered compulsory by legislation.

CONCILIATION AND THE MOULDER.

At the recent meeting at Cincinnati of the National Founders' Association, the Foundrymen of North America—the owners and managers of foundries—faced a problem which sooner or later our Employers' Federation will also be called upon to face. The moulders' unions of this country and of America are almost on a par. They are both powerful bodies; they have an ultra-conservative policy; they resent the introduction of all means of increasing output per man or the employment of non-members, and they are ready to strike as a whole if any of their regulations are disregarded in the smallest part. This cohesion amongst their members, and the fact that as a rule they act quickly on the offensive, has given them an advantage which few unions enjoy, and has invested them with such power that the masters prefer to conciliate rather than oppose them. Inspired by this spirit, the National Founders' Association in 1899 entered into an agreement with the Iron Moulders' Union of North America, which, it was vainly hoped, would put employers and employed upon peaceful terms, and would end the bickerings and strife which characterised the foundry trade. It was agreed between the Association and the Union that when causes of dispute arose, "reasonable effort" should be made to effect a satisfactory adjustment, but if that failed it was to be in the power of either party to refer the matter to a board of arbitration, consisting of the president and two members of both the Union and the Association, the finding of the majority of this committee to be "final in so far as the future action of the respective organisations was concerned." It is to be observed that although this is spoken of as a committee of arbitration, there is no arbitrator in the accepted sense of the word; there is no uninterested person, that is, to adjudicate between the claims of the opposing parties.

The National Founder's Association must have been sanguine indeed, if it imagined that such an agreement would prove satisfactory. Unions are like the despiteful lady, and are to be grasped firmly as one must grasp a nettle if he would avoid stings. This the Association has now learnt by bitter experience. It has found that the New York agreement, instead of being "the peacemaker for which it was intended, has become a trouble maker of no small proportions," for the Union has persisted in using "the deadlocking feature of this agreement to prevent the slightest progress of the proprietors towards the introduction of any change in wage rate or new conditions and improvements." Having thus prevented agreement in any locality, the Union then has had the men out at the first appearance of the slightest change. At the same time it basely attempted to enter into secret agreements with the more powerful masters, hoping thereby to seduce them from their allegiance, and gradually to undermine the whole fabric of the Association. Fortunately, this "diplomatic motive," as it is officially described, but which is uncommonly like ordinary treachery, has miscarried. The Association has been loyal to itself, it has resisted these attacks, and, finding a policy of conciliation futile, has now entered upon the first stage of a crusade, the end of which is not doubtful. It has begun by repudiating the New York agreement, and by boldly declaring that on matters which concern shop management, shop methods, and shop discipline, it will brook no interference from the Union. It recognises, however, that on the question of hours and wages the men have a right to be heard, and the masters will hear them, but any agreements at which they arrive will be as between themselves and their men, and the existence of the Union in that connection will be ignored. The text of the principal clauses in the Cincinnati resolution is printed on another page, and will be found worth perusal.

The importance of the step that the Association is taking can hardly be overrated. It means eventually the downfall of the Iron Moulders' Union and the establishment of the "open shop," the shop, that is, where the master is free to employ whom he pleases, in what capacity he pleases, an object for which all American employers are steadily and unceasingly working. That our "foundrymen," too, may some day be driven to take their courage in both hands, and declare their independence of the Unions, is by no means unlikely, unless the Unions are wise in season, and learn from their American brothers that trade can only be hindered and delayed up to a certain point. When that point is reached something breaks—and it is invariably the Union.

SIMPLE AND COMPOUND LOCOMOTIVES.

The controversy about the relative merits and demerits of simple and compound locomotives, which has raged for over a quarter of a century, affords, we think, an excellent example of the contentions about words rather than things, which have played such an important part in the scientific, religious, and political history of the nations. The merits and demerits of a locomotive really cannot be gauged from totally different standpoints. But the conditions under which railways are worked are so various in kind, so different in substance, so powerful in effect, that this particular controversy will probably last as long as the railways themselves.

When we examine with care all the facts and arguments which have recently acquired prominence, simply because others formerly in favour have been quietly shelved, we find that in favour of the compound locomotive it is urged that it is highly economical in fuel, and in favour of the simple engine, that it can pull with more power at all speeds than its rival. A locomotive superintendent finds that he has ample hauling power, and seeks to save fuel. He will favour compounding. Another engineer is short of power, and he favours the simple engine. All this is very plain and straightforward; but each party complicates the quarrel by claiming for his engine some of the merits of the other. Thus, we are assured that the compound engine is just as powerful a tractive machine as the simple engine; and we are assured, on the other hand, that the simple engine is on the whole as economical as the compound. The recent history of railway practice throws a good deal of practical light on these points, and in a way makes, we think, for the simple engine. An examination of the facts carried out dispassionately will be found to repay the trouble.

Let us take, in the first instance, the London and North-Western Railway. On it more completely than on any other in the kingdom has compounding been tried. Mr. Webb had a free hand, and his exceptionally clever brain devised one type after another of compound engines. No published data have ever been available to prove that his engines were exceptionally economical. Whether they were or not, the fact remains that the coal consumption per train-mile has been very heavy, because of the incessant piloting said to be indispensable. The most powerful compound locomotives on the line appear to be incapable of dealing single-handed with the express passenger traffic. We must repeat here that we do not pretend to give reasons, we content ourselves with placing facts before our readers, from which they can draw their own deductions. If a simple engine burns 50 lb. per train-mile, and can take a 350-ton train at the booked speed, it will be more economical than two compound engines doing no more work and each burning 35 lb. per train-mile; the compound engine is not worth having under the circumstances. Now, Mr. Whale was determined to get rid of pilots if possible; he concluded that the compound locomotives on the London and North-Western represented the best that could be done in that direction, and accordingly he resorted to the simple engine, providing great boiler power and a high pressure. What the result has been has been fully set forth in our pages by Mr. Rous-Marten within the last few days. We do not know what Mr. Whale's new Precursors burn per mile, but we are none the less certain that it cannot be as much as two compounds or a big compound and a small simple engine at the head of a train will require. Here we have an instance of the reasons why two persons may hold opposite views. Mr. Whale has "to get his trains there" at the fixed time. One compound engine cannot do it. The fact that it may be quite economical matters not at all. Mr. Whale wants power first and economy next; but on a line where a compound engine would alone be quite up to the work its economy would constitute an admirable feature, entitling it to the preference. So far, then, the facts go to show that the compound engine is not sufficiently powerful to comply with the conditions of modern express railway traffic. We have selected the London and North-Western Railway because on no other line in Great Britain has the compound system been so fully and fairly tried; but it must be remembered that on the Great Eastern and the North-Eastern the system has been tested on a considerable scale and abandoned. On the Midland Railway it is under trial now; it remains to be seen with what success. No importance need be attached to the statements made concerning any type of engine during the first year or so of its life. A much longer period than that is required to determine the fitness of the type to the work of any particular railway.

Thus far we have the simple engine appearing to be the best, but when we turn to France we find the de Glehn compound appears to be doing work so exacting that it is not quite easy to find a parallel for it at this side of the English Channel. It will be remembered that Mr. Rous-Marten has recorded in our pages particulars of magnificent work done by de Glehn engines in France, and that we have asked repeatedly for an explanation of why speeds have been attained and weights hauled by one engine which could not be equalled by two locomotives in this country. No answer has ever been attempted. One very suggestive fact may be mentioned. It will be remembered that Mr. Churchward recommended his directors to procure a de Glehn compound. This was done, and La France has now been working express traffic on the Great Western Railway for some months. The results are so satisfactory that an order has been given to a French firm for three or four more. But we are told that they are to be larger and more powerful than La France. This fact goes some way, we think, to prove that the conditions under which a locomotive works in this country are really somewhat less favourable than those obtaining on the Continent. Again, we point out that we are not attempting to give reasons, but simply stating facts.

Turning to the railways of Europe, we find that, apart from the de Glehn system, we have that of Von Borries, Du Bousquet, Borsig, and many others. It is noteworthy that the boiler-power provided is never less for the compound than it is for the simple engine, the pressure carried is almost invariably higher, and that superheaters are very usually fitted. The conclusion to be drawn is that, after all, it is to the boiler that we must look for hauling power; and that, no matter with what economy the steam may be worked, trains cannot be pulled at the required velocity unless the supply is as ample for one type of engine as it is for the other. No doubt splendid work is being done by compound locomotives, but there is after all these years a lamentable absence of definite information. It is not worth disputing the statement that compound locomotives are burning 10, 15, or 20 per cent. less coal than simple engines. Many other things have to be considered besides coal, and the figures mean nothing unless all the conditions of traffic are stated. We believe that under certain well-defined conditions compound locomotives must be better than simple engines; but before an opinion can be pronounced with propriety it is essential that it should be known whether these conditions do or do not exist. Personally we hold that on a great British railway with a very fast and heavy traffic the simple engine with a very big boiler and fire-grate will in

the long run give most satisfaction. Further, we hold that for very fast work four-coupled wheels are ample, and there is visible at this moment a tendency to think as we do on this question among locomotive superintendents. This, however, is another story. The patent fact just now is that the compound system has had a very full test in this country, and that it has been found wanting. Mr. Churchward's experiment is, of course, a new departure. It remains to be seen what will come of it. If the de Glehn engine is not ultimately as successful here as it has been in France, that will, we think, go far to prove that there is some essential, if subtle, difference between the conditions of haulage on, let us say, the Northern Railway of France and the Great Western of England; but it is just on such differences that the merits or demerits, the success or failure, of any particular type of locomotive will depend, always assuming, of course, that workmanship and materials are in every case equally good.

THE BRITISH WESTINGHOUSE COMPANY, LIMITED.

ABOUT five years ago a great undertaking was commenced in this country, very novel in many respects, peculiarly interesting in all. It had been freely argued that, whatever merits British manufacturing methods might possess in other things, in all that related to electrical engineering they were antiquated, slow, and deficient. The British Westinghouse Electric and Manufacturing Company, Limited, began operations at Trafford Park, and it was soon noised abroad that American methods would be used, and lessons taught far-reaching in their effects. Who does not remember the stories told of the phenomenal rate at which bricks were laid and the walls of a gigantic establishment were run up? All that was most recent in tools, everything most desirable or desired in a place of the kind, was provided, and the British manufacturer stood aside and waited with bated breath for the result. Time passed, and it began to dawn on the world that perhaps, after all, American methods might not be the best for this country. As the years went on it became more and more evident that the company had not discovered the royal road to fortune, and now we have before us the report of the fifth annual general meeting of the shareholders, and the address of the chairman, Mr. William J. Buchanan, delivered in the absence of Mr. Westinghouse, we commend to the attention of our readers. From first to last it is an apology and a lament — an apology for failure, a lament that bright hopes formed have not been realised. Mr. Buchanan was, however, nebulous in places, and it is not at all times easy to arrive at definite conclusions as to matters of fact. So far as we can gather, however, there has not been any lack of business. In the five years' life of the company, orders to the value of over £5,000,000 had been received. But instead of a return of 20 per cent. or even of 10 per cent. on these orders, the profits seem to have been minute, and absorbed in the repayment of loans. "On July 31st last their sundry creditors were £374,678 and their temporary loans stood at £200,750; on October 31st the sundry creditors were £248,562, and there were no temporary loans." These loans could not be obtained at a lower rate of interest than 4½ per cent. The £5 preference shares of the company now stand, it was stated at the meeting, at about £2 10s. The interesting fact here is that we find a great company with plenty of orders unable to earn a profit, and the excuse put forward is that competition, home and foreign, has compelled the taking of orders at a price which cannot be made to pay. But there are powerful British companies making machinery of the same kind paying excellent dividends; from all which it seems to us that the lesson is to be drawn that those who have exalted American manufacturing systems at the expense of our own have overlooked some element—national, psychological, whatnot—which plays an important part in the conduct of affairs. No doubt there was much to be said in favour of Mr. Buchanan's comments on the effect of foreign competition. This competition presses hardly on persons who have been accustomed to manufacturing under Protection. With this, however, we need not now concern ourselves. *The* point is that an American works with enormous capital, and huge orders, should have not only failed to make a profit in the past, but that those in control should be far from optimistic about the future. It must, however, be satisfactory to the shareholders to know that "the board of directors realise the difficulties they had had to contend with and those which were still before them, and their obligation to do everything in their power towards bringing about the results hoped for by all and confidently believed in by the principal proprietors."

ANTARCTIC EXPLORATION.

AN interesting advertisement is now to be found in shipping papers. The Discovery Antarctic exploration steamer is for sale. She is thus described:—"Wooden barque-rigged auxiliary screw steamer, now lying in the East India Dock, London. Specially built by Dundee Shipbuilders' Company, at Dundee, in 1900, for the British Antarctic Expedition; framing of British oak, and planking of American elm and pitch pine, sheathed with iron bark and greenheart. Length, 179ft. 3in.; breadth, 33ft. 8in.; with a mean draught of 16ft., and displacement of 1570 tons. Triple-expansion engines by Gourlay Brothers and Co., Dundee; 550 indicated horse-power; cylinders, 14½in., 22½in., and 36in. by 30in. stroke; steams seven knots on about seven tons; lifting propeller and rudder. Complete electrical installation fitted with special regard to scientific purposes. Is amply found in stores of every description, and is in first-class order. For further particulars, with orders to inspect, apply to David Bruce and Co., 10 and 11, Lime-street, London, E.C." We fancy that this advertisement must be almost unique. Possibly some of our readers can tell us what became of former Arctic and Antarctic ships. The first of importance were, no doubt, H.M.S. Hecla and Fury, commanded by Captain Parry in his search for the North-West passage. As the desire for adventure in cold countries seems to be insatiable, it might prove to be a very good speculation to buy the Discovery as an investment. She ought to last half a century with moderate care, and a purchaser might turn up at any moment.

THE ITALIAN BATTLESHIP VITTORIO EMANUELE III.

ON the 5th October the first-class battleship Vittorio Emanuele III. was successfully launched at Castellamare, in the presence of the King of Italy. With the possible exception of H.M.S. King Edward VII., there has not been a more discussed warship within recent years. As her *pros* and *cons.* were thoroughly gone into in our issue of March 15th, 1901, at the time when she was first projected, it will only be necessary to briefly enumerate her special features. First and foremost of these is the total abolition of the 6in. gun, mounted in all Italian warships up to the Benedetto Brin, its place being taken by the 8in. gun, with a reduction in the number of 12in. guns from four to two. The special arrangement of these is something after the style of the Russian Tsarevitch, except that the amidships turret is a deck higher than the others instead of lower. Secondly, she has been given a designed speed of 22 knots, which will probably reach 23 on actual trial. Here we have a factor which at once eliminates the uncertain line between the battleship and armoured cruiser. Larger and more powerful enemies like the Connecticut or Lord Nelson she could easily outdistance if unwilling to fight, while very few foreign armoured cruisers could show her a "clean pair of heels."

As originally designed she was to have carried a battery of twelve 4in. guns. These have now been altered to 3in. 12-pounders, a distinct change for the better, as with practically equal destructive power against torpedo craft, a more rapid rate of fire can be maintained with the smaller gun.

In the following table it will be seen how she compares with the latest designs of the Powers of her displacement or thereabouts:—

	Italy. Vittorio Emanuele III.	Great Britain. Triumph.	France. Suffren.	Germany. Braunschweig.	Russia. Ekstaf.	U.S.A. Idaho
Date launched	1904	1903	1901	1902	Building	Building
Displacement	12,625 tons	11,800	12,728	13,200	12,600	13,000
Dimensions	435 × 73½ × 26	436 × 71 × 25	410 × 70 × 27	400 × 72 × 26	371 × 72 × 27	375 × 77 × 24
Armament—						
Main	2 12in. guns	4 10in.	4 12in.	4 11in.	4 12in.	4 12in.
Secondary	12 8in.	14 7·5in.	10 6·4in.	12 6·7in.	16 6in.	8 8in.
Tertiary	12 12-pdrs.	14 14-pdrs.	8 4in.	12 5½-pdrs.	16 12-pdrs.	8 7in.
Auxiliary	12 3-pdrs.	4 6-pdrs.	2 9-pdrs.	12 1-pdrs.	6 3-pdrs.	20 14-pdrs.
	4 Maxims	4 Maxims	24 3-pdrs.	8 Maxims	6 1-pdrs.	12 3-pdrs.
						8 1-pdrs.
Torpedo tubes (submerged)	4	2	4 (2 above water)	6 (1 above water)	3	2
Protection—						
Belt	10in.—4in.	7in.—8in.	12in.—6in.	9in.—4in.	9in.—2in.	9in.—4in.
Lower deck side	8in.	7in.	5in.	5½in.	6in.	7in.
Protective deck	4in.	3in.—1½in.	3in.	3in.	3in.	?
to big guns	8in.	10in.—8in.	12in.	11in.	12in.	12in.
Secondary	6in.	7in.	5in.	7in.	5in.	7in.—6in.
Indicated horse-power	20,000	12,500	16,200	16,000	10,600	10,000
Speed	22 knots	19 knots	18 knots	18 knots	18 knots	17 knots
Coal supply (maximum)	2800 tons	2000	1150 + oil	1500 + oil	900 (normal) + 580 oil	1750

Without a doubt, in the near future other nations will embody the general features of her design in their battleships. Already a monster 20,000-tonner is being projected in the United States of America, carrying only twelve 12in. and a large number of 8in. guns, with a speed of 20 knots or over, to all intents a replica of Col. Cuniberti's "Ideal"—dealt with in "Fighting Ships," 1903—whilst the Lord Nelson, with her four 12in. and ten 9·2in. guns, is practically a development of the Vittorio Emanuele on a larger scale.

DOCKYARD NOTES.

THE St. George has replaced the Northampton as training ship, and the old armoured cruiser which once possessed, "to a marked degree the virtues of both battleship and cruiser," will pass into that limbo to which the King Edward will follow her after perhaps no longer a term of service. The Cuniberti battleship, "an absurd vision" but three years or less ago, is now well on the way to be accepted as the standard to aim at in all navies. A Lord Nelson is probably worth a couple of Londons; the battleship of the future will undoubtedly be better than the Lord Nelson, thus rendering the King Edward little less obsolete than the old Northampton "armoured cruiser."

THE Northampton, by the way, embodied a peculiarity of naval construction; "a ram designed to be taken off, in peace time, in order to obviate disaster should she collide with other warships!" Either because peace never seemed sufficiently assured or because of mechanical difficulties, the ram always stayed on, however. It is triangular in shape and quite thin. This conveyed another advantage. After ramming the enemy the ram would break off and so save the Northampton the bother of extricating herself from the enemy's interior! We talk of modern progress, but there was little left unthought of in the old days. They forgot one thing in the Northampton, however—they omitted to give her speed. At her best she did more often under eleven knots than over it, and for the last ten years or so she has varied between eight and six knots, with a preference to the latter. Her engines, however, were extremely well made. Her sister, the Nelson, was a much better steamer, and has been known to make as much as thirteen knots or more. But even this giddy figure fails to suggest flying.

The U.S.S. Colorado, designed horse-power 23,000, and 22-knot speed, on trial worked up to 28,016 indicated horse-power (average 27,000). The resulting speed was 29 knots in excess of contract. Air pressure 1½in. Boilers Niclausse. A sister ship, the West Virginia, required, it is reported, 2in. of air pressure to achieve corresponding results with her Babcock boilers.

PERMANENT WAY FOR TRAMWAYS.

A PAPER, entitled "Notes on Permanent Way for Tramways," was read recently by Mr. A. N. Connett before the Tramways and Light Railways Association. The paper is divided into the following sections:—Rails, joints, special work, curves, construction, and paving. The author, dealing with the first of these—rails—has a few words to say regarding the proposals by the Standardisation Committee. He is in entire agreement with the sections selected, but does not believe in too rigid an adherence to the specifications suggested by them, although, if properly interpreted, they may be quite correct. He points out that continental engineers differ from those in this country and the United States in that they leave the manufacturer a free hand in the design of sections, provided that the physical tests give satisfaction, as they consider the latter sufficient to indicate the quality of metal to be used. But there is always a risk that the engineer may specify certain chemical requirements which may seriously affect the physical properties of the steel. Mr. Connett, continuing, shows that there is now no likelihood of change in the section of tram rails in this country for some considerable time, owing to the new regulations of the Standardisation Committee. The rail they have selected is the "girder" type, and the author considers that there is no better section made at the present time. Many and varied are the opinions of engineers on the question of joints. This particular detail of the permanent way is one of considerable importance, as there is no doubt that much money would be saved if a suitable one was designed. Considering only for the time being mechanical joints, such as splice bars of special form, &c., the author states that it is necessary for a well-designed bar to have the following features:—

(1) Large area of bearing surface at top and bottom.

(2) The maximum thickness of bar that circumstances will permit.

(3) The vertical member of the bar slightly convex in relation to the web of the rail.

(4) A clear theoretical distance of from ⅛in to ¾in. on the fishing surface of the rail, top and bottom, to be left after the bars are finally fixed in place.

(5) Long splice bars, say, between the limits of 26in to 32in.

Great importance is attached to the method of fixing; and the best bearing surface possible must be obtained. "The splice bars should be put on square, and at first only drawn up sufficiently to hold the rails snugly. After the rails are surfaced the bolts should be drawn up tightly, using a spanner of not less than 2ft. in length, at the same time tapping the head with a light hammer. Finally, the bolts should be gone over in the same way, just ahead of the paving work." The author has every confidence in this class of joint, and states that it will give excellent results provided that the joints are opened up and refixed once a year. Some interesting remarks are also made on welded joints. This class may be sub-divided into cast weld joint, electric weld joint, and the thermit weld joint. The first two of these are said to give good results, but in both cases the initial outlay is considerable, and both require a formidable plant. The thermit weld is accomplished by a chemical process, and up to the present has given good results. It has the great advantage of requiring only a small plant, which is easily handled. The author considers the welding process limits the amount of line which can be laid by the plate-laying gang, and consequently the progress of the work is determined by the rate at which the joints can be made.

Nothing new has been added to what is already known about the wear of curved rails, but the author thinks that with the introduction of a standard type of curve much better results will be obtained. And, before long, a new material will be used for rolling curve rails, probably nickel steel. Some interesting remarks are made on the method of constructing the permanent way. There does not seem to be any probability of substituting any other material for concrete as at present used, as, taking everything into account, it is considered to be the most suitable for the purpose. The two ways of setting the rails on the concrete are given; in the first one the concrete is laid to within about 1in of the proper surface for the base of the rail, and the rails are then laid on the concrete, and surfaced by blocks or wedges. The space between the rail and concrete is then filled with fine concrete. The other method—and the one which the author considers the better—is to pack up the rail to the required level, and then place the concrete, in one operation. If the foundation is insufficient there will be settlements, and it is suggested that it might be practical to use ferro-concrete under and beyond the track for the purpose of increasing the bearing surface without using a prohibitive depth of concrete. Very little is said on the question of paving. A few words are given relating to the expansion of wood setts, thus causing an alteration in the gauge of the track. But with a 7in. rail and a 4in. depth of block it is considered that there need be no fear of this occurring. The concrete must come up 3in. from the base of the rail, and surrounding it, so that it is held tightly, and can resist lateral movement. Expansion then causes the wood "to arch" from the rail. "With deeper blocks, or shallower rails, or the combination of both, there is a danger of the rails moving or tilting."

NAVAL ENGINEER APPOINTMENTS.

THE following appointments have been made at the Admiralty:—

Engineer Lieutenants.—J. F. Bell, to the Terror for charge of T.B.'s Engine-room Stores and Torpedo Sub-depôt, to date December 3rd; H. M. Wall, to the Fire Queen for the Success, undated; J. A. Owen, to the Egmont for the Flying Fish; and J. T. C. Butland, to the Leander for the Foam, to date November 29th.

Engineer Sub-Lieutenant.—H. Hodson, to the Fire Queen, supernumerary, to date December 3rd.

THE CASTLE CARY AND LANGPORT RAILWAY

SKEW BRIDGE OVER THE CASTLE CARY AND SOMERTON ROAD

BRIDGE OVER THE RIVER PARRET

CLEARING FOR SOMERTON STATION

SOMERTON TUNNEL—WEST FACE

THE GREAT WESTERN COMPANY'S NEW ROUTE TO THE WEST.

THE important undertaking of the Great Western Railway Company, known as the Castle Cary and Langport Railway, forms the last chapter of an old-established project for furnishing a shorter and more direct express traffic route to Exeter, Plymouth, and all Cornish stations. At present the Great Western route is the longer by 23 miles to Exeter, and by 16 miles to Plymouth, than that of the London and South-Western Company to the same points; and although it is, on the whole, the more favourably graded, the express traffic is apt to be delayed at such important junctions as Didcot, Swindon, Bath, and Bristol.

By examining a map of the Great Western system it will be seen that the company possesses the nucleus of an alternative route to the West in the lines lying south of the main line west of Reading. There is the Berks and Hants Railway, once a separate company, which extends from Reading to Westbury *viâ* Newbury and Hungerford, and at Westbury joins the Weymouth branch, which leaves the main line at Chippenham. The idea of utilising the Berks and Hants Railway as an alternative route to the West was first conceived many years ago. Originally, however, this line did not proceed direct to Westbury, for it formerly joined the Weymouth branch nearer Chippenham, at Holt Junction, passing through Devizes on the way. Accordingly, in order to convert the nucleus into a through route the following works were necessary. First, the doubling of the Berks and Hants line from Reading to Woodborough; secondly, the construction of a railway from Woodborough to Westbury, to avoid the *détour viâ* Devizes and Holt; and, thirdly, the construction of a railway which would link up the Weymouth line with the Bristol and Exeter Railway.

The doubling of the Berks and Hants line, and the new railway between Patney and Chirton Junction, two miles west of Woodborough, and Westbury were both completed in the autumn of 1900. The Patney and Chirton and Westbury line, which is 14¼ miles in length, with stations at Patney and Chirton, Lavington, and Edington, was fully described in THE ENGINEER of November 23rd, 1900. Incidentally, the construction of this link gave the Great Western Company a shorter route to Dorchester and Weymouth. The South-Western route to Weymouth is 142½ miles long. Formerly, the Great Western Company had the choice of two routes, both considerably longer, viz., *viâ* Swindon and Chippenham, 168¾ miles, or *viâ* the Berks and Hants line, Devizes and Holt Junction, 160¼ miles. By the opening of the Patney and Chirton and Westbury cut, the Great Western acquired a route only 154½ miles in length, thus enabling the company to compete on better terms than previously with the London and South-Western. In the summer of 1901 the Great Western Company started an accelerated Weymouth service *viâ* Patney and Chirton, and during the past summer it ran to Weymouth in the same time as the South-Western, while some of its trains ran without a stop between Paddington and Maiden Newton, a distance of 139½ miles, track water troughs having been laid on the new line between Edington and Westbury.

The second link of the chain for providing the Great Western Railway with shorter access to Exeter and Plymouth is a new line to connect the Weymouth branch south of Frome with the existing main line between Bridgwater and Taunton. Now there is a branch line, of single track, from Durston on the main line, six miles north of Taunton, to Yeovil on the Weymouth line, but it is too circuitous for the purpose. Therefore a railway is being built from Castle Cary, 20 miles south of Westbury, to near Langport, on the Durston-Yeovil branch.

As far back as 1883 a Bill was obtained for a line between these points, but these powers were allowed to lapse. In 1898 the scheme was revived, and in the session of 1899 a fresh Bill was passed. The later project is somewhat different from that which preceded it. The survey of the first line went farther south than the present, and the Bill of the latter makes provision for important works on the existing line between Langport and Athelney, and also for a deviation west of Athelney.

The Castle Cary and Langport Railway was begun in May, 1903, and, owing to the favourable weather which was experienced in 1904, the works are in a very forward state.

The new line diverges from the Weymouth branch 300 yards south of Castle Cary Station, which is 115¼ miles from Paddington, *viâ* the direct route, and extends for a distance of 15¼ miles, passing through an extremely picturesque and hitherto remote part of Somersetshire. The line is, of course, designed for two lines of way, but no provision is being made at present for duplicating the track capacity; should a four-track way ever be needed.

After leaving Castle Cary Junction the line runs on a bank for three miles, which is followed by a cutting through shale and clay, three-quarters of a mile long, 40ft. deep, and containing 300,000 cubic yards. At 4¾ miles, and in a shallow cutting, is the site of Keinton Mandeville Station. A quarter of a mile beyond there is another big cutting through blue lias, half a mile long, 32ft. deep, and representing 80,000 cubic yards, whence the line continues on a bank or on the surface to Charlton Station, seven miles. At 7¼ miles a formidable cutting through shale and rock is encountered, for, though only thirty chains in length, it attains a depth of 65ft., and represents 380,000 cubic yards. This cutting is followed by a bank, 38ft. high, until at 8½ miles the road from Castle Cary to Somerton is crossed by a fine skew bridge at an angle of 30 deg. The bridge consists of six ribbed arches on the square, with a span of 62ft. each. Another lofty bank, half a mile long, followed by a cutting 50ft. deep and a quarter of a mile in length, brings the line to a viaduct spanning the valley of the little river Cary. The Somerton Viaduct, as it is called, will comprise five arched spans of 50ft. each, and the rail level will be 63ft. in height. The line next passes through the village of Somerton in a deep cutting, and at 10½ miles, where the cutting terminates, is the site of Somerton Station, which will be the most important on the line.

Soon afterwards another cutting, three-quarters of a mile long, 45ft. deep, and representing 100,000 cubic yards, begins, and continues to the eastern face of the Somerton Tunnel. This tunnel is in hard marl and shale, 1054 yards in length, while its depth beneath the surface averages 120ft. The perforation is not quite straight, for seven chains at the western end are on a curve of one mile radius. The tunnel has one permanent shaft near the western extremity. From the western portal of the tunnel to a new station at Langport, 14½ miles, there are two important banks and two big cuttings. The first cutting is one mile long, 35ft. deep, and contains 154,000 cubic yards; and the second is three-quarters of a mile long, 33ft. deep, and of 160,000 cubic yards. On leaving Langport Station the line enters upon an angle of King's Sedgemoor, whose treacherous surface is crossed on an embankment 25ft. in height. The embankment, however, is punctured by both a viaduct and a bridge across the river Parret. First, there is the viaduct, which will comprise ten arched spans of 55ft. each. The foundations of the piers are being sunk to a depth of 50ft. through the peat. The Parret is a tidal river, and navigable for barges. The bridge—fifteen miles—consists of four arched spans of 39½ft. each, and one steel span of 105ft., formed by a Warren braced pillar girder structure.

The new line effects a junction with the Durston-Yeovil branch at 15½ miles from Castle Cary Junction, and half a mile from the old Langport Station on the branch.

The Castle Cary and Langport line is designed for the heaviest and fastest main line traffic. With the exception of a long reverse curve at Somerton it follows practically a

straight line throughout. The sharpest curve is that at Somerton, the radius of which is sixty chains, while the radius of the few others is one mile. There are two long stretches of straight, beginning at 2 miles 64 chains, and continuing to 5 miles 17 chains; and beginning at 12 miles 20 chains, and continuing to 15 miles respectively. The ruling gradient is 1 in 264, and, roughly speaking, the line ascends from Castle Cary to Somerton, and thence descends to Langport. There are fifty bridges under and over the railway. With the exception of stone quarries at Keinton, Charlton, and Somerton, there is practically no local traffic to be developed. The intermediate stations will be of the ordinary double-platform pattern. The whole line, in short, is designed purely for the requirements of an express traffic. The first section from Castle Cary to Charlton is in such a forward state that it will be opened for rail motor cars on July 1st, 1905. The remaining works are as follows:—The existing line from Langport to Durston crosses Sedgemoor practically on the surface, or, at an altitude of only 3ft. In the winter and spring this line is being constantly flooded and washed out, owing to the failure of the wooden culverts to relieve the pressure of the flood water. Accordingly, the line as between the junction with the new railway at Langport and Athelney Station, a distance of four miles, is being entirely reconstructed. A new double-track railway is building alongside the old, and being carried 10ft. above the surface of the moor instead of 3ft., while wooden culverts are giving place to brick and steel, supported on piles, driven 30ft. on to the solid. From Athelney a deviation will be made for a distance of three miles to a junction with the old main line at a point three-quarters of a mile north of Taunton. It will, therefore, be seen that the last part of the scheme for a new route to the West entails the construction of 22½ miles of double lines of way. The contractors for the whole undertaking are Messrs. C. J. Willis, of Manchester and Westminster.

Good progress is being made with the Langport and Athelney section, but work on the deviation beyond has only just been begun. It is anticipated that the whole will be ready for public service in time for the summer traffic of 1906. Taken in conjunction with the already opened Patney and Chirton and Westbury line, the Castle Cary and Langport Railway and accompanying works will have the effect of stringing the bow as between Reading and Taunton. Travelling by the new route, the Great Western journey to Exeter will be exactly 21 miles shorter than it is at present *vid* Swindon, Bath and Bristol. In two years' time, therefore, the London and South-Western Company will only have the advantage of the Great Western by two miles to Exeter, while to Plymouth its route will become five miles the longer, whereas it now is 16 miles shorter. In addition to the saving of distance which it will effect, the new route will also give the Great Western trains a much more favourably graded road than is furnished by the old main line. Lastly, by avoiding Didcot, Swindon, Bath and Bristol, the new route should secure to the company's best express trains in the West of England service an absolutely clear run throughout.

SEWAGE DISPOSAL AT HANLEY.

AN interesting report has been recently made to the Sanitary Committee of the Staffordshire County Council by Dr. Geo. Reid, the County Medical Officer of Health, regarding a series of experiments which he has been carrying on in connection with sewage disposal at Hanley. Rather over two years ago the Corporation of Hanley, in consequence of an undertaking which it had given, decided to construct works for treating one-sixth of the dry weather flow of the sewage of the borough on biological lines. The object was to determine by experiment, on a large scale, whether septic tank treatment, followed by single filtration, would yield satisfactory results with the sewage in question. It was also desired to find out whether, if this process were found to be efficient, it could be conducted on the site of the present outfall works, which is near to a populous part of the borough.

The experimental plant was designed by Messrs. Willcox and Raikes, engineers, of Birmingham, in conference with Dr. Reid, and in planning it regard was paid to possible future extension of the works on similar lines should the experiments prove successful. The installation had been practically in constant operation for some eighteen months at the date of the report to which we have referred. For many years previously the method of disposal of the sewage of Hanley had been chemical precipitation followed by land treatment. The land, however, is clayey and most unsuitable for the purpose. Moreover, the area is inadequate. It was perfectly evident, therefore, that if the original outfall were retained, all idea of land treatment, even as a supplement to other methods, must be discarded.

Dr. Reid states that it was known that septic tank treatment of the sewage, followed by double filtration, would produce a satisfactory effluent. There was a pretty firm conviction that, with a highly efficient method of distribution of the tank effluent on the filter, one filtration through a depth of filter of about 4ft. 6in. would answer the purpose. A waste material called "saggars," which is very plentiful in the pottery towns of North Staffordshire, was known to be a good filtering medium when broken up. It is hard and non-friable. What was not known, however, was the size of medium most suitable to employ. The experiments in the result pointed very strongly to the proper size, or rather combination of sizes, which gave the best effluent.

It was decided in the first instance to erect a Scott-Moncrieff distributor, which was specially designed for this particular installation, and which worked throughout the experiments on a circular filter bed. Later on a further mechanical distributor was designed by Mr. Willcox, and put to work on a square filter. Dr. Reid's remark, regarding both of these, is that they complied with the stringent conditions regarding efficiency which had been laid down in the first instance. The total area of the filters amounted to half an acre, consisting of a circular quarter-acre bed fed by the Scott-Moncrieff distributor, and a rectangular quarter-acre bed fed by the Willcox distributor. The total depth of filtering material was in both cases 4ft. 6in. In order to determine what sizes or series of sizes of filtering material it was best to employ, the expedient of sub-dividing the beds was resorted to. Thus, the circular bed was divided into four sectors, and the square bed into two halves. The sizes of particles of filtering medium in the various sections of the two beds was as follows:—

Circular Filter.

Section I.—6in. of 2½in. to 1½in.; 3in. of 1½in. to ½in.; and 3ft. 9in. of ⅛in. to ½in. particles.

Section II.—6in. of 2½in. to 1½in.; 3in. of 1½in. to ½in.; and 3ft. 9in. of ½in. to ¼in. particles.

Section III.—9in. of 2½in. to 1½in.; and 3ft. 9in. of ½in. to ¼in. particles.

Section IV.—9in. of 2½in. to 1½in.; and 3ft. 9in. of 1½in. to ½in. particles.

Rectangular Filter.

Section I.—1ft. of 1½in. to ½in.: and 3ft. 6in. of ⅛in. to ¼in. particles.

Section II.—1ft. of 1½in. to ½in.; and 3ft. 6in. of ½in. to ¼in. particles.

It will be observed that the sizes of the particles at the tops of the filters in Sections I. and II. were the same in both filters. The object of this was to allow of a legitimate comparison being made between the results of the two filters worked under identical conditions and differing only in the mechanism for distributing the sewage. Effluent pipes were so arranged as to allow of distinct samples from each section being collected for analysis.

These filters were fed with a septic tank effluent. It was at first arranged that the tank should be large enough to hold a twenty-four hours' flow of sewage. The routine working of the works, however, generally interfered somewhat with the regularity with which the detritus tank was emptied, with the result that a larger proportion of the mineral suspended solids in the sewage passed into the septic tank than would otherwise have been the case. This curtailed the effective capacity of the tank more rapidly than usual. The effect was that the septic tank effluent was not the outcome of twenty-four hours' septic action throughout the whole period of the experiment, and that at times an increase in the suspended solids passing from the septic tank to the filters probably resulted from this unavoidable shortening of the septic period. The rate of flow in the case of the circular filter was constant and regular at 200 gallons per superficial yard. In the case of the square filter, this flow was not always maintained, but varied from 130 to 200 gallons, the mean being 162 gallons per square yard. The rate of travel of the distributor was so arranged that each portion of the area of the filter received its dose at regular seven-minute intervals. It will be remembered that this was the time experimentally found some years ago by Mr. Scott-Moncrieff to give the best results.

We may here state that the sewage dealt with is an ordinary domestic sewage not of a very strong character. The dilution is accounted for by the discharge into the sewers of a considerable volume of mine drainage water as well as a certain amount of stream water from a small tributary stream, which, having received some sewage from Hanley and the adjoining borough of Burslem, communicates with the outfall sewers.

Attached to the report are a number of tables giving in detail the results of the analyses made of the sewage and of the effluents from the septic tank and from the various sections of the two filters. These are, unfortunately, too long for us to reproduce in full, but a table is given setting out the means of all the results, and this we reprint below.

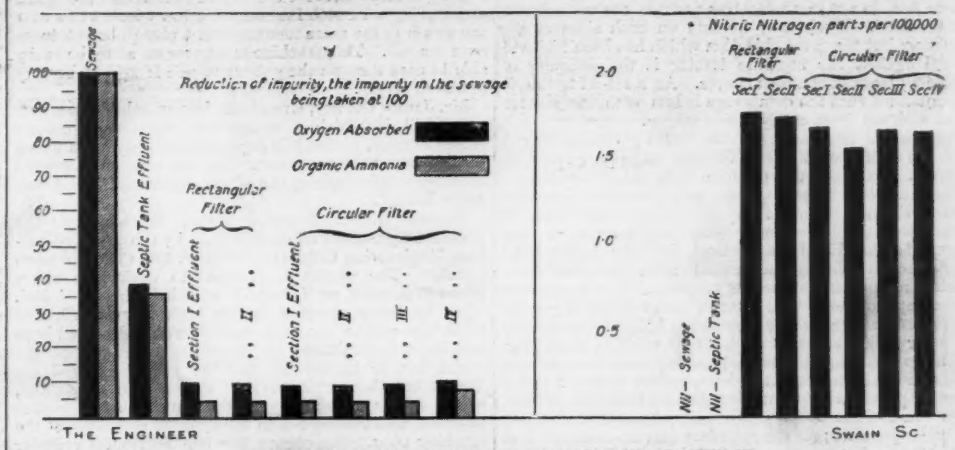


DIAGRAM SHOWING PERCENTAGE PURIFICATION OF SEWAGE

Sample.	Size of particles in body of filter.	Number of samples.	Parts per 100,000. Solids. In solution.	Solids. In suspension.	Solids. Total.	Chlorine.	Free ammonia.	Organic ammonia.	Oxygen absorbed in four hours at 80° Fah.	Nitric nitrogen.
Sewage	—	8	125·4	62·9	188·3	8·9	2·109	0·765	3·854	0·00
Septic tank	—	7	105·3	4·4	109·7	8·7	1·820	0·270	1·725	0·00
Rectangular filter, Section I.	⅛in. to ¼in.	14	112·0	0·4	112·4	8·5	0·081	0·029	0·273	1·75
Rectangular filter, Section II.	¼in. to ½in.	14	111·9	0·3	112·2	8·3	0·008	0·032	0·278	1·73
Circular filter, Section I.	⅛in. to ¼in.	13	112·1	0·2	112·3	8·4	0·006	0·025	0·242	1·66
Circular filter, Section II.	¼in. to ½in.	13	112·9	1·4	114·3	8·3	0·036	0·029	0·259	1·58
Circular filter, Section III.	½in. to 1in.	13	112·8	0·7	113·5	8·4	0·037	0·030	0·252	1·62
Circular filter, Section IV.	1½in. to ½in.	13	113·1	1·7	114·8	8·3	0·119	0·046	0·327	1·61

These results have been embodied in a diagram which shows clearly the percentage purification effected in the various sections of the filters. This diagram we reproduce above. It will be seen from a consultation of this table and diagram that the septic tank effected a purification of 64 and 62 per cent. in the organic ammonia and in the oxygen absorbed figures respectively. The filter effluents showed a purification of from 94 and 91 per cent. in the case of the large grain section of the circular filter to 97 and 94 per cent. respectively in the case of the finest grain section. These last-named figures are practically the same in the corresponding section of both filters. As regards the degree of nitrification, the results are practically the same in all sections of both filters.

Dr. Reid, commenting on the results generally, says that the degree of purification which has been effected in every case is excellent. "The good quality of the work done," he adds, "exceeds that of any plant of which I have had experience, neither do I know of any published records from similar works which will approach those of Hanley as regards degree of purification effected."

With regard to the routine working of the filters the report states that, with the exception of a temporary water-logging of the large grain section of the circular filter—1½in. into ½in. particles—an occurrence which was corrected by a short period of rest, no trouble was experienced. "That this occurrence," it is added by Dr. Reid, "should have happened in the case of the large grain section only, confirms the accuracy of the opinion I formed years ago, namely, that it is desirable to reduce the size of particles in such filters to an extent which is compatible with thorough aëration." Of course, the question of cost has to be considered. The crushing of the filtering materials into very fine particles adds to the cost of construction. The conclusion arrived at, therefore, is that it would be wise to make use of particles of the same size as those forming the body of Section III. of the circular filter, namely, ¼in. to ½in. With this grade of material, however, it would be wise to protect the filter by forming the top layer, to the depth of about 9in. to 12in., of ⅛in. particles.

PUMPING HEAVY LIQUIDS.

IN many industries it is necessary to force heavy, viscous liquids through pipes. This involves difficulties not encountered in ordinary pumping, and requires machinery special in design and construction. When the liquid is heavy, but not adhesive, as in the case of crude oils, the action can be made fairly satisfactory and efficient by enlarging the valve openings, making the parts of the pump heavier, and so arranging the passages of the pump that there is little liability of choking or clogging. When, however, the liquid is a fluid at high temperatures, and a gelatinous adhesive paste or a rubbery solid, clinging to all surfaces and choking openings through which it should pass, as the temperature is lowered, a design differing materially from the ordinary pump must be used. Tar, molasses, and cocoa liquor present more obstacles to pumping than any other substances which it has been found feasible to move in this manner. Each of these liquids thickens into an almost solid mass when cold, rendering it very difficult to start the pump if some special provision is not made and ample power provided. Another action which must be taken into account is the contraction of the area of the passages and valves as the liquid cools, and the consequent throttling which interferes with the liquid's passage, and which the pump is forced to overcome. The skin friction of a liquid of this kind creates heat enough partially to alleviate this tendency to throttling when the velocity of the substance is maintained above a certain point and the pipe is not in such a position that the surrounding air will lower the temperature of the liquid below the solidifying point. Although not a common practice, it is well to lag all exposed piping used for conveying heavy oils or other substances of a similar nature. Gas tar has a number of characteristics rendering it exceptionally difficult to pump. Its condition varies from a solid to a penetrating fluid within a small range of temperature.

Another liquid peculiarly difficult to handle is oil-refinery tar, which is usually very hot when it reaches the pump. There is a large percentage of suspended particles of various sizes present in this tar, and also a certain amount of unrefined paraffin. The tar is sometimes heated to a temperature of 300 deg., but quickly cools off if not properly handled, and coats the retaining valves and walls with layers of an adhesive substance closely resembling finely-divided particles of coke. To overcome the difficulties the ordinary pump arrangement and design are materially changed. Exceptionally large valve areas are employed, the valves being designed to permit the passage of the substance pumped with the least possible frictional resistance.

THE total sum which the London County Council will have to pay for the purchase of the London, Deptford and Greenwich Tramways Company's undertaking is £96,500—£1000 in excess of the estimate approved by the Council.

THE SMITHFIELD SHOW.

ALTHOUGH the list of exhibitors of machinery and agricultural implements in the catalogue of the above annual exhibition contains the names of most of the firms which have become prominent in their different spheres, there are very few appliances which are not replicas of predecessors well known to most of our readers. If there is a predominating feature of the machinery section this year, it is the prominence which is now being bestowed by makers of traction engines or heavy road locomotives upon lighter types of self-propelled vehicles, either in a form suitable to carry the farmer's products or capable of being yoked to existing vehicles in place of horses or other forms of haulage. That many of the engineering firms are moving somewhat timidly in this new departure is scarcely to be wondered at, for the wheels of great Government departments turn with oppressive slowness, and the three-ton tare limit imposed by the Light Locomotives Act has not yet been replaced by a more adequate allowance, although a Local Government Board announcement has been expected for some time past. The builders of the older types of road locomotive still remain obdurate respecting the advantages of the steam motor wagon, but are becoming more alive to the demands for light steam tractors which, while coming within the scope of the above Act, do not in themselves provide accommodation for the load. Much may be said on both sides of the question, but the great objection which has been hitherto raised against the separate tractor is the difficulty of handling loads in confined spaces. As a set-off to this, it is contended that the demurrage is less with the tractor than with the more costly motor wagon.

The latest firm to enter the ranks of steam wagon builders is that of Richard Garrett and Sons, Limited, Leiston. As we hope to describe their vehicle somewhat fully in a future issue, we need only give here the chief features which it embodies. In general appearance it resembles closely several other well-known wagons. Steam is provided by a vertical fire-tube boiler, fired from the top through a central tube, and the outer shell is removable for cleaning purposes. The engine is of the compound horizontal pattern, with few moving parts. Between the high and low-pressure cylinders is a controller cylinder which contains a piston movable by the driver with the following results:—(1) high-pressure steam may be admitted direct into the low-pressure cylinder and a passage provided for exhausting the high-pressure cylinder, in which position both cylinders are operated with steam at boiler pressure; (2) the cylinders may be operated with two stages of expansion; (3) in this position the exhaust from the high-pressure cylinder is closed and there is no supply of steam to the low-pressure cylinder, and in this position the engine may be stopped at will, sufficient retarding effect being obtained to control the vehicle in busy thoroughfares. There are two countershafts, and the spur-wheel differential gear is fitted to the second. This gear can be locked at will. The road wheels are all of Krupp cast steel, and motion is transmitted from the differential shaft to the driving wheels by Renolds' bush-roller chain. The engine is non-reversing, an intermediate shaft with pinion, operated by a lever near the driver's seat, is provided when it is required to run the vehicle backwards. The lorry is designed to carry four tons, and gives the impression of being capable of dealing with still heavier loads.

The firm of Savage Brothers, Limited, King's Lynn, adopted the policy of the open mind, and lays itself out to suit either the purchasers of tractors or motor wagons. The principal features of the latter, which have already been dealt with in these pages, are still adhered to. The water-tube boiler, which forms a special feature of this vehicle, in proper hands, has been found to give satisfaction. It has ample heating surface, and, with a very active circulation, freedom from scaling is said to be attained. The wheels are of wood, made of the "Artillery" pattern, having steel bushes, brass bushed and securely fitted to the centre of the wheel. The outside tires are of steel, with smooth surface and of good width for road work.

The steam tractor has a single-cylinder engine, 6½in. by 12in., a 4 nominal horse-power boiler, with large fire-box, and a special form of cast steel wheels with I section spokes. The engine is mounted on springs and has two speeds. The water capacity is 90 gallons, sufficient for a journey of 8—10 miles.

Aveling and Porter, Limited, also exhibit a light steam tractor in addition to their heavy engines. This engine has been specially designed to work under the Light Locomotives Act for hauling one wagon, one man only—the driver—being required in attendance. It is fitted with two travelling speeds of 3 miles and 6 miles per hour respectively, and will take a wagon with a 4-ton load over any ordinary road. The boiler and fire-box are constructed of the best mild steel plates of ample size; gearing of the best cast steel, and the crank, counter and driving shafts of the best steel. The engine is mounted on Aveling's improved arrangement of laminated steel springs to both hind and front axles; is fitted with winding drum with steel wire rope, powerful brake acting on the inside rim of each driving wheel, worm and wheel steerage, and compensating gear.

Other exhibitors of these light tractors are Messrs. Clayton and Shuttleworth, Limited, Lincoln; Wallis and Steevens, Limited, Basingstoke; and Messrs. Wm. Foster and Co., Limited, Lincoln. Messrs. Wallis and Steevens are also introducing a trolley with patented backing gear, by means of which the engine can push its load backwards, without uncoupling, into almost any position. The provision of such a vehicle goes a long way towards removing the disadvantage which the light steam tractor has suffered from in comparison with the motor wagon, and we hope shortly to place before our readers an illustration of this vehicle.

Amongst the very few really new implements shown is a "fore-and-aft" swath turner made by Mr. T. M. Jarmain, Haseley Ironworks, Oxon. This machine has been designed in a manner which, while retaining the good features of the earlier machine, is lighter in draught and sufficiently narrow to pass through a 7ft. gateway, while there is likelihood of choking when dealing with heavy crops. The improvements consist in placing the left-hand or "near" side flier in front of the axle, and the right-hand or "off" side flier to the rear of the axle, instead of having both the fliers behind. By this arrangement the road wheels are brought much closer together and the fliers are nearer to the axle. The frame of the machine is extended forward, and the fore part is carried by a swivel wheel, the front flier being suspended from the frame. A lever is provided for adjusting the height of the flier, and for raising when necessary to clear obstacles. The swivel wheel enables this flier to ride over ridges and furrows, in the same way as the rear flier, which is carried by a trailing wheel as hitherto.

Another new machine which comes under the same category is shown by Mr. Robert Maynard, of Whittlesford Works, near Cambridge. It is built to deal with two swaths simultaneously, and the tines revolve in and with drums, but the drums and tines are not concentrically arranged. The drums revolving give motion to the tines in such a way that they protrude at one side of the drum, and disappear on the other side where the swath is leaving, making it impossible for the hay to wind round the drum, and leaving a smooth face on the drum which wipes over the swath in the same manner that a plough breast turns over the soil. This machine is narrow so as to be easily able to pass through the gateways, and is said to be very gentle in action.

Mr. James Coultas, Grantham, has on exhibition a new corn drill in which a spring acts upon each coulter independently, so that it is depressed into any holes which the machine may encounter. He has also an improved arrangement for setting the whole of the coulters at any angle desired.

Messrs. G. H. Innes and Co., Hitchin, show the Rational high-speed oil engine, built by the Heatly-Gresham Engineering Company, Limited, 110, Cannon-street, London. The engine is designed to work with either petrol or paraffin, or, if desired, with both kinds of fuel. With the latter object a double tank is provided, and when the engine has been started on the spirit and been running a few minutes, by an arrangement of taps the petrol can be turned off and the paraffin turned on. The carburetter employed is of the Cremorne type, and, we are told, a satisfactory gasification of the heavy oil is obtained without deposit in the cylinder or fouling of the sparking plug. The engine has one horizontal cylinder 4¾in. × 4¾in. and gives three effective horse-power when running at 600 revolutions per minute. An electrical high-tension system of ignition is employed, and a simple enclosed governor operating the throttle renders the engine suitable for small electric lighting installations such as may be required in country mansions. The automatic system of lubrication has been well thought out. Oil is poured into the crank-chamber, but it does not work on the splash principle, the oil being lifted by the gear wheels and conducted to the various points requiring lubrication by collecting fins. The valves are made of a special metal, which is claimed to have a longer life than usual in this class of engine. The whole forms a highly compact and inexpensive source of motive power which should meet with a good demand.

As usual, oil engines form a very conspicuous feature of the show; amongst the firms exhibiting this class of prime mover being Messrs. Blackstone and Co., Stamford; Brown and May, Limited, Devizes; Campbell Gas Engine Company, Limited, Halifax; Crossley Bros., Limited; Fielding and Platt, Limited, Gloucester; Richard Hornsby and Sons, Limited, Grantham; J. and F. Howard, Bedford; Newtons Limited, Taunton; Ruston, Proctor and Co., Limited, Lincoln; C. F. Wilson and Co., Aberdeen; Carson and Toone, Wilts; Thomas G. Slipper and Co., Norwich; F. C. Southwell and Co., London; and J. B. Petter and Sons, Limited, Yeovil.

Marshall, Sons and Co., Limited, Gainsborough, show amongst other of their well-known engines a new type of 7 horse-power compound traction engine with three road speeds. It is constructed to work economically in steam consumption, and embodies several improvements in detail. This engine is provided with a small horizontal steam pump outside the tender above the road wheels, instead of the ordinary force pump. A long-stroke horizontal engine, with cylinder 10in. by 24in., and made from new patterns, is fitted with Marshall's trip gear, and is provided with equilibrium double-beat inlet and exhaust valves. Messrs. J. and F. Howard's exhibits include the new swath turner, which we alluded to in our description of the Royal Agricultural Society's show last year. The past season's working has led to the substitution of spring tines for those made of sheet metal. Otherwise no alteration has been made. In the self-tying long straw press a new conveyor has been provided, which renders it more silent in operation, while reducing the number of parts. Messrs. Ransomes, Sims and Jefferies, Limited, Ipswich, show a wide variety of engines, including an 8 horse-power nominal road locomotive, for continuous hauling purposes. It is capable of hauling from 25 to 30 tons in fast gear, at four miles an hour, over fairly good and level roads, or it will draw 20 tons up a gradient of 1 in 12 at the same rate; a 7 horse-power nominal traction engine for driving and hauling thrashing machines, steam cultivation, &c.; an 8 horse-power portable engine, with cylinder of large diameter, reversing and variable expansion excentric, high-speed governor, and boiler with ample heating surface; a long-stroke stationary engine, with main frame in one casting, of the circular hollow type, steam jacketed cylinder, and automatic expansion governor. There is also a high-speed vertical engine for driving dynamos, centrifugal fans, pumps, and other high-speed machinery. This is specially recommended for ship-lighting plants, being very compact and simple in construction; every part is easily accessible, and all reciprocating parts are accurately balanced.

Where deep tillage of the land is required steam cultivation has been found most effective, and the firm of John Fowler and Co. (Leeds), Limited, has, it is almost needless to state, for many years made a speciality of steam ploughing tackle. Steam ploughing is effected on either the double-engine or the double drum system. In the latter case one engine travels along one headland, while an automatic self-moving anchor travels along the opposite headland. This system is chiefly adapted for small farms. A compound spring-mounted road locomotive, the largest that can be used in England under the present Act of Parliament, is shown. The boiler is designed for a working pressure of 180 lb. In emergencies high-pressure steam can be admitted into the low-pressure steam chest by means of a starting valve, which closes automatically, the engine then working double cylinder with high-pressure steam, thus giving off its maximum power. The driving cranks are set at right angles; thus a uniform speed of rotation is obtained. The engine can be readily started and reversed, and when hauling the load is steadily taken up.

Agricultural engines and road locomotives are also shown by Messrs. Ruston, Proctor and Co., Lincoln; William Allchin, Limited, Northampton; Aveling and Porter, Limited, Rochester; Charles Burrell and Sons, Limited, Thetford; Clayton and Shuttleworth, Limited, Lincoln; William Foster and Co., Limited; Richard Garrett and Sons, Limited; J. and H. Maclaren, Leeds; and Wallis and Steevens, Limited, Basingstoke.

OIL FUEL.

THE United States Government tests, recently carried out by a specially-appointed Board and now reported upon, seem to show a very much lower percentage of the evaporative duty per pound of oil when burned as a fuel than can be obtained in this country. After a series of exhaustive tests on many injector burners sent to the United States Admiralty for competition, two injectors were selected by the Board from the group as giving the best results. A new series of tests were made with these two injector burners, bringing out the fact that there was nothing to choose between them. The oils used in testing these two burners were California crude, and semi-refined Texas. The heating powers of the oils used are not given, but they are supposed to be equal. The Texas crude oil varies between 19,500 and 20,690 B.T.U.'s, and as the oil used was semi-refined to bring out its highest heating power, it may be reasonably assumed that it would not be less than the latter figure, viz, 20,690 B.T.U.'s. Taking, however, both figures, the lower and the higher, viz., 19,500 and 20,690, these give a theoretical—say, 100 per cent.—evaporation of 20·16 lb. and 21·40 lb. of steam respectively per pound of oil calculated from and at 212 deg. Fah. Such figures in practice are not obtained, as so much is used up in radiation, conduction, flue heating, &c., which altogether amounts to a considerable percentage. The result of the series of tests carried out by the United States Board on the two injector burners referred to above, on an average came out 12·29 lb. of steam per pound of oil with the one, and 12·08 lb. with the other, calculating from and at 212 deg. Fah., which may be taken to be about 60 per cent. duty. Doubtless these figures are high, probably as high as an injector burner will go, but they are low when compared with other systems in use on this side of the water. Thus, Professor Watkinson, of Glasgow, carried out a series of tests with the system of the Lucal Light and Heating Company, of Glasgow, and obtained results far in advance of those obtained by the Board appointed by the United States Naval Bureau. His results showed that combustion was practically perfect, and that an effective evaporation of 75 per cent. was obtained by an apparatus fitted up in his presence and tried for the first time, while with a little careful working it ran up to 84 per cent., a point beyond which it is barely possible to go when the usual furnace allowances are taken into consideration. Thus, with the oil used in the United States tests giving as mentioned above, 19,500 as lowest and 20,690 B.T.U.'s as highest, the Lucal system at 75 per cent. only, gives an evaporation of 15·12 lb. and 16·05 lb. of steam per pound of oil from and at 212 deg. Fah., while 84 per cent. gives 16·93 lb. and 18 lb. respectively. The following are the tabulated figures. The oil used was crude blast furnace.

As obtained by the United States Board.

	Burner No. 1.	Burner No. 2.
Oil used having, B T U.'s	19,590 or 20,690 ..	19,500 or 20,690
Theoretical, or 100 per cent., evaporation of steam, from and at 212 deg. Fah., per pound of oil	20·16 lb., 21·40 lb. ..	20·16 lb., 21·40 lb.
Average evaporation obtained in United States	12·29 lb., 12·29 lb. ..	12·08 lb., 12·08 lb.
Being, per cent.	60·95, 57·45 ..	59·92, 56·45

As obtained by the Lucal System.

At 75 per cent. as above	15·12 lb., 16·05 lb. .. 15·12 lb., 16·05 lb.
At 84 per cent. as above	16·93 lb., 18 lb. .. 16·93 lb., 18 lb.

It may be added, in addition to the above, that while it took 4½ per cent. of the total amount of steam formed to atomise the oil by the injectors, as found by the United States Board, Professor Watkinson found that the Lucal device only took 1½ per cent.

MOTOR CARS FOR CEYLON.—The Government of Ceylon are inviting tenders for motor car mail services between (1) Bandarawela and Badulla, twice daily each way, total 72 miles; (2) Badulla and Batticaloa, once daily each way, 134 miles; (3) Matale and Trincomalee, once daily each way, 194 miles; (4) Colombo and Chilaw, twice daily each way, 200 miles; (5) Chilaw to Puttalam, once daily each way, 64 miles. The cars will have to comply with the following conditions:—(*a*) When fully equipped and loaded with a weight of a ton in addition to equipment there shall not be a weight of more than three-quarters of a ton on any wheel, nor shall the whole car, when loaded and equipped, weigh more than three tons; (*b*) each car shall be capable of carrying six passengers and 3 cwt. of baggage, at the rate of ½ cwt to each passenger, in addition to the driver; (*c*) the car shall have a special locked receptacle for the mails; this receptacle shall be capable of containing 3 cwt. of mails, which would probably require a space of about 30 cubic feet; (*d*) the car when loaded must be able to work easily at a pace of eight miles an hour on the flat, and be capable of ascending and descending gradients at a pace of six miles an hour; (*e*) it must be able to run 30 miles without renewing the supply of water, petrol, or other necessary; (*f*) the car must be so covered as to give sufficient protection against sun or rain.

THE RAILWAY COAL CONTRACTS.

No branch of the coal trade is more important than that relating to steam coal, and hence the anxiety displayed in fixing the large railway contracts for supplies of locomotive coal. The week has been an important one to Yorkshire coalowners, who have tendered at 8s. 6d. per ton pit prices for six or twelve months. This year, if the owners stand fast by their promise not to take less than the prices quoted, there seems no reason, judging from circumstances at South Yorkshire collieries where the 9ft. seam is worked, why they cannot succeed. At this time last year several large firms were in possession of vast stocks of coal, which caused prices to rule low. In fact, the Lancashire and Yorkshire Railway Company obtained supplies in the Wath and Mexborough districts at 8s. 3d. per ton, being 3d. and 6d. below what other companies paid. This year it is stated that several firms, which usually play an important part in the letting of the contracts, are sold well forward, and have little coal on hand. Tenders have during the latter part of last week, and during the present one, been sent to the Midland, Great Eastern, Great Northern, Lancashire and Yorkshire, and North-Eastern Railway Companies, at the price named. No branch of the coal trade in South Yorkshire has undergone so many changes as that relating to supplies of locomotive coal. In 1887 they fell as low as 6s. 6d. per ton, but in 1888 they advanced to 8s. 6d. per ton, the price now asked. During the years 1890 and '91 they rose to 10s. 6d. In 1892 the contracts were let at from 9s. 6d. to 10s. per ton, and in 1892 and '93 9s. to 9s. 6d. was the price obtained, and some collieries incurred much odium for taking contracts at 8s. 9d. per ton. Prices afterwards varied a good deal, and during 1900, as high a price as 15s. to 16s. per ton was obtained in July of that year. A good few contracts from the previous year were, however, still running at 10s. 6d. per ton. At the close of 1901 the owners agreed to send in tenders at 9s. 6d. per ton, but as usual there were waverers, the Lancashire and Yorkshire Railway Company, which is usually the first to break down prices, placed some portions of their contract at 8s. 9d. per ton. The North-Eastern and Great Northern, however, paid 9s. per ton. For a few years prices relating to contracts have not varied a great deal, the North-Eastern and Great Eastern are paying 8s. 6d. per ton for a portion of the coal they consume, and as the former company consume from 400,000 to 600,000 tons, some idea of the importance of even a small reduction may be formed. The Midland and Great Northern, which tendered for a year's supplies, have paid 8s. 9d. per ton, but, as stated, the Lancashire and Yorkshire, which at the close of last year held back, deprived collieries on their own lines of the contracts and placed them elsewhere at 8s. 3d. per ton. The action was strongly condemned by miners, who suffered a good deal owing to the withdrawal of the orders. A good deal of anxiety is felt as to the issue. The decision of the North-Eastern is first expected, and is generally closely followed by the Midland and Great Northern Companies. It may be stated that prices fixed by the contracts generally rule with little variation in regard to shipping and other supplies.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE annual dinner of the Institution of Electrical Engineers took place on the evening of Thursday, the 1st inst., at the Hotel Cecil. The President, Mr. Alexander Siemens, was in the chair. Among a large number of distinguished guests were Lord Strathcona, Lord Alverstone, Lord Biddulph, Sir E. Carbutt, Sir H. Buckley, Rear-Admiral Sir A. J. Durston, Major-General Sir A. E. Turner, Sir C. Fremantle, Sir A. Noble, Sir J. Norman Lockyer, Sir John Wolfe-Barry, Sir W. de W. Abney, Sir W. Ramsay, Sir James Dewar, Sir Douglas Fox, Sir Alexander Binnie, Sir A. W. Rücker, and Sir J. W. Swan. After the dinner there were the usual loyal toasts by the President, after which Lord Alverstone proposed the toast of "The Institution of Electrical Engineers" in an eloquent speech, which was replied to by the President. Mr. R. Kaye Gray then proposed "Our Transatlantic Kinsmen," which was responded to by Lord Strathcona, the High Commissioner for Canada, and Mr. William I. Buchanan, the managing director of the British Westinghouse Company. The toast of "Our Guests" was proposed by Mr. Robert Hammond and replied to by Sir Henry Buckley.

NATIONAL FOUNDERS' ASSOCIATION.

AT the meeting in Cincinnati, November 18th, of the National Founders' Association an announcement was issued, of which the following are the principal clauses:—

"Inasmuch as certain practices, insisted upon by labour organisations, tend towards counteracting the energy, ability, inclination, and opportunity of moulders to earn greater compensation than they are now receiving, it shall continue to be the policy of the Association not to permit the limitation of a man's earning capacity, whether he is working by the day, by the piece, or premium system, thus protecting our workmen in a desire to improve their conditions.

"Believing the action of labour organisations in inflicting upon their members fines and punishments for accepting opportunities of advancement and increased earnings offered by the foundrymen is a practice tending towards the deterioration of the ability of the individual workman, this Association hereby reaffirms its determination to prevent the imposition of fines and restrictions placed on a moulder for the purpose of handicapping him or retarding him in any way from putting forth his best efforts to produce the best quality and quantity of work in the shortest time, and receiving a proportionate compensation.

"Employés will be paid by the hourly rate, by premium system, piece work, or contract, as the employers may elect, and the workmen so employed will be required to give a fair day's work for a fair day's pay.

"It is the privilege of the employé to leave our employ whenever he sees fit, and it is the privilege of the employer to discharge any workman when he sees fit.

"The number of apprentices, helpers, and handy men to be employed will be determined solely by the requirements of the employer.

"It shall be the right of the foundryman to introduce moulding machines and appliances of any kind, and to have the same operated by whomsoever he finds to his best advantage to employ thereon.

"Disapproving absolutely of strikes and lock-outs, the members of this Association will not arbitrate any question with men on a strike. Neither will this Association countenance a lock-out on any arbitrable question unless arbitration has failed."

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

H.M.S. TERRIBLE.

SIR,—In a leading article in THE ENGINEER, 25th November, 1904, page 124, notice is taken of some glaring inconsistencies in the reported deductions from two runs—to China and back to this country—made by H.M.S. Terrible; the first in 1902 and the other in 1904. Some suppositions are made of circumstances which might have influenced these runs, but are neither definite nor adequate as an explanation.

When the Terrible's first trials, under natural and forced draught, were made, the results published were as follows:—

H.M.S. Terrible.

Speeds V, N. miles.	Revolutions N, per minute.	Powers E, indicated horses.
13·4	64·5	5,111
22·4	112·0	25,572

Which are consistent with, and represented by, the formulas:—

$$E = 76{\cdot}56\ V\ 10^{\cdot 0329V}.$$
$$,, = 16{\cdot}07\cdot N\ 10^{\cdot 0511V}.$$
$$N = 4{\cdot}554\ V\ 10^{\cdot 0016V}.$$

It is stated the first China run was made at an average speed of 11·8 n. miles, with an average power of 5738 indicated horses, while the second, with 6in. greater draught, the speed averaged 12·6 n. miles, with the average power 4692 indicated horses. Surely the devil (printers') has been playing pranks, and substituted a 5 for the initial 3 of the power for first run, which ought to read 3738, not 5738. The speed is understated, and, seemingly, ought to be 11·84 n. miles. Also, to extend the field of action, from another source, at 19·6 n. miles the indicated horse-power was 15,544, the corresponding speed for which is 19·464 n. miles. as shown by applying the first of the above formulas to the respective speeds, as follows:—

H.M.S. Terrible.

Speeds V	=	11·84	13·4	19·464	22·4	12·6
Logs V	=	1·0734	1·1271	1·2892	1·3502	1·1004
Log ·0529	=	− 2·7235	− 2·7235	− 2·7235	− 2·7235	− 2·7235
Sums	=	− 1·7969	− 1·8506	·0127	·0737	− 1·8239
∴ ·0529 V	=	·6365	·7087	1·0·97	1·1850	·6667
Add logs V	=	1·0734	1·1271	1·2892	1·3502	1·1004
And log. 74·56	=	1·8716	1·8726	1·8726	1·8726	1·8726
Sums, log E	=	3·5725	3·7084	4·1915	4·4075	3·6397
						I.H.P.
∴ E	=	3,737	5,110	15,544	25,574	·4363
						I.H.P.
By data	,, =	3,738	5,111	15,544	25,572	·4692
						I.H.P.
Differences	=	− 1	− 1	0	+ 2	− 331

The last column shows the second China run figures by the same formula, over 300 I.H.P. less than the observed average. But this difference has to be diminished by the power required, by displacement, due to 6in. extra draught in this run. This would account for a large proportion of this difference, and we could scarcely expect close agreement on such a length of run, and variations in so many disturbing influences. ROBERT MANSEL.

Dunblane, Perthshire, December 5th.

SIR,—I am obliged to "A Son of a Sea Cook" for pointing out an error in figures. The result is the same, however. The coal for culinary purposes, &c., is taken as the coal out of the bunkers not burned in the boilers. He assumes the crew to be 700, and so each man has required 41 lb., 34 lb., and 79 lb., of coal daily to cook his food. I do not know the grate area of cooking ranges, but assuming 20 square feet used for all such purposes, the consumption per square foot of grate per hour becomes 59 lb., 48 lb., and 115 lb. of coal all through the 56, 50, and 59 days' voyaging. Evidently sea cooks should be taught that scientific spreading of coal mentioned by "Navalis."

In addition to coal for cooking, each man required an expenditure of 51 lb., 9 lb., and 266 lb. of coal daily for auxiliary purposes in harbour on the three voyages respectively.

I am still further perplexed by "Navalis'" explanation. I think he is wrongly informed, and suggest his searching your back numbers, in which he would perhaps read that the Terrible's career has not been without boiler fatalities. I cannot agree that the original jointing of her pipes was so blameworthy, for before her was the very successful "Speedy," carrying 210 lb. of steam jointed on the Thornycroft plan, and whose boilers have, I surmise, burned at least ten times the coal per square foot of heating surface during her career that any Belleville ship has done in the same time. Further, it is unlikely that engine makers of high repute, such as at Thompson's and Barrow-in-Furness, would have acted as he represents. If he is right as to the 1902 expenditure being due to leaky steam pipes, then this would have entailed an extra expenditure of 1944 tons of coal for a loss of 16,040 tons of steam in her voyage of 936 hours. It is inconceivable that 17 tons of steam per hour should have so leaked.

Why not credit the fire-room staff of 1902 as being capable after being in the ship two years, many of them with prior training in the Sharpshooter? Otherwise the mystery deepens, as the raw hands of 1904 are so praised. I fail to see that the repairs of auxiliary service boilers—whatever may be meant—and the renewing of three fusible plugs has any bearing on the question.

Perhaps the whole business is a triumph for some anti-fouling composition coating the bottom; if so, such is worth its weight in gold as a curtailer of horse-power, increaser of speed, and a saver of public funds. I commend to "Navalis'" notice the subject of inefficient and wasteful sea cooks.

December 6th. PERPLEXED.

SIR,—The discussion about this ship is interesting, and in no way more so than in the light which it throws on the use which may be made of figures. These figures prove absolutely nothing about increased efficiency in the vessel. There is no relation whatever between the increased speed and the power developed. The figures prove that on one voyage she was driven at a more economical speed than she was on another, and that is all.

There is a fixed speed for every ship, at which she will do better than at any other velocity.

If the Terrible was driven at speeds varying through a considerable range the voyage must be costly in fuel. To run 100 knots (*a*) at one speed, and 100 knots (*b*) at double that speed, means that (*b*) would burn about eight times as much coal as (*a*) per knot On the other hand, if the speed is too low, the engines being much too large for the power, waste steam by condensation in a way well understood.

Somebody has been "filling up" "Navalis" about leaky steam pipes. Nothing of the kind could be tolerated. A very minute quantity of steam will smother an engine-room in fog.

Liverpool, December 5th. SUPERINTENDENT ENGINEER.

THE DISESTABLISHMENT OF BEN NEVIS OBSERVATORY.

SIR,—Having perused the proceedings of the Leith Chamber of Commerce in the papers of Saturday, the 12th ult., on the question of the disestablishment of the Ben Nevis Observatory, I write a line to say that I fully concur with the terms adopted by the meeting, and that I am pleased to note that a similar attitude has been taken up by the Chamber of Commerce in Glasgow and in Aberdeen.

The question had become political as well as financial, insomuch that the Observatory had by lapse of time and use become an industrial trust or firm, as it had in its maintenance a large staff of employés, consisting of contractors for food, forage, coal, wood, horses, carts, navvies, messengers, telegraph, and other accessories.

All these were in daily and weekly use, besides the few scientific observers, who were but a fraction compared with those of the maintenance, and most of them have now been turned adrift or elsewhere to seek fresh situations and employments. To excuse this wholesale eviction it has been alleged that the Ben Nevis Observatory was of little or no use to Scotland in weather information, but this idea seems to be founded in ignorance of the terms of subsistence of a twenty years' arrangement. A grant of about £350 was sent to it from a London fund to meteorology, so that Ben Nevis would furnish them with the work done by reports, tables, summaries, telegrams for the issuing of forecasts, &c.

No mention was made of duplicates for Scottish use, and London got everything, for which was paid a handsome subsidy, while Scotland was debarred from making any official advantage of the work done.

In France, Germany, and America, these institutions are put upon a departmental basis, and have staffs appointed by their respective Governments, which are relieved and retired by the same agency.

The roads are maintained by the County Councils, the buildings by municipal rates, and the salaries and equipment by Government national funds.

At the Puy de Dome, in France, there is a good road all the way up, properly metalled and fenced; you can hire a fly for 5f., and get a good lunch at the restaurant at the top, or a bed if a longer stay is wanted. At this time of day the Ben Nevis Observatory might be maintained in permanence by an annual vote by Parliament, like the vote for education, and not by an elementary subsidy called a grant, through the medium of an institution in London.

Some time since, in consequence of this incongruity of feeling, I proposed that the Ben Nevis Observatory should think of cutting its connection with London and enter into terms with Berlin and the German observatories, as there is much consentaneity between the weather of the Baltic and the North Sea, and both might assist each other by helpful forecasts. A very good case of the use of the Ben Nevis Station took place in the case of the present storm, December 4th—6th, when the cyclone passed through the South Hebrides and over the Observatory, which by bad luck was then closed and unable to forward intelligence to the public.

W. W. BLACK, F.R.M.S.

Edinburgh, December 8th.

REACTION IN A DIVERGING NOZZLE.

SIR,—"Testor" asks on what area is the pressure exerted when an elastic fluid is expanding in and escaping from a diverging nozzle.

As "Testor" has mentioned a nozzle of 1in. diameter at the narrowest part, and 3in. diameter at the exhaust end, this nozzle will serve as an example. Let us suppose that the nozzle acts ideally, that there is no loss of energy, all the heat energy given up by the steam being converted into kinetic energy and leaving the nozzle as such. The actual conditions in a good nozzle, at least within certain limits as regards temperature, pressure, and velocity, do not differ sufficiently from this ideal state to upset the reasoning; and there seems to be no use in the present instance to attempt to allow for friction, eddies, &c., which differ considerably in different circumstances.

Let us suppose that air is the working fluid. When it has reached the neck of the nozzle—the part of 1in. diameter—the pressure will have fallen to about 0·53 of its original amount, the temperature will have dropped to correspond, and the air—assuming that it was supplied to the nozzle with a velocity negligibly small—will have acquired a velocity V_R, corresponding to the fall of temperature. If m is the mass of steam discharged per second by the nozzle, then the reactive force due to the velocity already given to the steam will be $V_R \times m$. This force, I should say, was exerted on the vessel supplying the nozzle, part of the force really being due to a reduction of pressure on the inlet portion of the nozzle on the pressure side of the neck, below the static pressure in the vessel supplying the nozzle.

The rest of the expansion of the air takes place in the diverging part of the nozzle from which the air issues with velocity V; and I should say that the rest of the reactive force, namely, $(V - V_R)\ m$, is borne by this part of the nozzle; that is, the part between the 1in. diameter section and the 3in. diameter section. I cannot say that I see that this question of the allocation of the reactive pressure is important, and I hope, Sir, that I have not taken up too much of your space with it.

The other point raised by "Testor" is, however, of great importance. He says that if the discharge velocity of the fluid was 5000ft. per second—presumably relatively to the nozzle—and if the velocity of the nozzle was 5000ft. per second in the opposite direction, there could not be any recoil effort. I say that there certainly would be a recoil effort. If, at a point on the earth's surface, where the velocity due to the rotation of the earth on its axis is 1400ft. per second, a gun is fired so that the projectile is given a velocity of 1400ft. per second relatively to the earth in the opposite direction, would "Testor" say that there was no recoil?

R. M. NEILSON.

30, Cross-street, Manchester, December 5th.

THE PROPOSED NEW PASSENGER STEAMERS FOR THE THAMES

SIR,—Having read with much interest the article referring to the above which appeared in your issue of the 2nd inst., I should like to point out that the suggested working speed of twelve miles an hour is too slow for a river like the Thames, where the tides ebb at the rate of between four and five miles an hour.

This means crawling back from say, Woolwich, at less than eight miles an hour, which performance is no better than the boats used to achieve in the days of the Victoria Steamboat Association, and many times have I undergone that experience.

Then, again, why compound engines only? thus losing all the acknowledged benefits resulting from triple and quadruple-compounding, not to mention water-tube boilers.

To show a good profit in working, the new boats should be able to do fifteen miles an hour in still water, and be run at frequent intervals not exceeding ten minutes. Possibly twin or triple-screw steamers would be more suitable than paddle boats, constructed on the lines of the new twin-screw passenger boat Mona, built last year for the Tyne General Ferry Company.

LOFTUS PATTON PERKINS.

43, Regent-square, Gray's Inn-road,
London, W.C., December 5th.

HOT BRASSES.

SIR,—Can any of your readers inform me how to cure the case of hot brasses as follows:—Two gas engines of 100 horse-power each drive every alternate week a 5in. shaft through fast and loose pulleys. The loose pulleys are 5in. diameter, 15in. wide, are bushed with gun-metal, each pulley has two bushes with a space between them, they are 4½in. long each, and are ⅜in. thick, lubricated with Stauffer's grease. When, say, A engine is driving, the 5in. shaft runs in B loose pulley, B engine being still. The loose pulleys are less in diameter than the fast pulleys, to give a slack belt. The bushes are in line and round, but they get hot, and we have to take off the belt of the still engine. The drives are about 20ft. centres, and nearly vertically up. Various greases and oils have been tried without the slightest success. HOT BRASSES.

December 5th.

THE Great Western Railway Company has recently increased the number of workmen's trains in and near London, and has reduced the workmen's fares between certain stations.

LAYING CONDUIT ACROSS SCARDALE VALLEY

THIRLMERE WATER PIPES.

IN common with other places, Manchester during the autumn has been concerned by reason of the lowness of its water reserve. In order to ease matters as much as possible, the laying of the last line of pipes to connect with Thirlmere was hurried on and recently completed. The above engraving shows one of the most difficult bits of engineering in the whole line between Manchester and Thirlmere. It is where the conduit crosses the Scardale Valley, and a good idea of the country traversed at this point may be obtained from the engraving. We may mention that the pipes are 48in. in diameter, and in 9ft. lengths. The thickness varies from 1¼in. to 1⅜in., and the weight from 2 tons 16 cwt. to 2 tons 7 cwt.

THE PROGRESS OF THE LIGHT MOTOR CAR.

IN the course of a paper on this subject read before the Automobile Club on the 24th inst. Mr. W. W. Beaumont dealt with several practical questions affecting the design and construction of motor cars and motors, some of which have not before been discussed. After tracing the history of the light car, he said:—

We arrive then at the time of the Hereford Trials, the first durability trials arranged by the Club for small cars only. Thirty-eight cars were entered, and 26, or 68 per cent., of them completed the trials, or 72 per cent. if we exclude two that did not put in an appearance. They were nearly all two-seated cars, as in 1900, yet the smallest of them had engines of 6 horse-power, or about 100 per cent. more power than the average of the little cars of 1899, and many of them had engines of from 130 to 170 per cent. more powerful than the 3 horse-power of 1899. Of the thirty-eight cars that entered for the trials there were thirty which had transmission and speed change gear of the sliding type.

Two only were driven by side chains.
Five were driven by a single chain from engine to live axle.
Four were driven by single chain from countershaft to live axle, and of these
Three were driven by a chain from the crank shaft to first motion spindle in the gear box.
Twenty-four were driven by a jointed propeller shaft from gear box to bevel wheel on the live axle.

A considerable number of the cars had horizontal engines, most of them had single-cylinder engines of the De Dion make or De Dion type by other makers.

The trials lasted a week, covered about 615 miles—not including runs to and from the washing yard—through country which included a number of very stiff hills. The trials were of the non-stop kind, and included consumption test, brake tests, hill-climbing trials, and, to a certain extent, mechanical efficiency tests. Observations were also made on the relative noise, vibration, comfort, and ease of manipulation of the twenty-six cars. The results, numerical and otherwise, of the trials, have been so fully and recently published in numerous technical and other journals, and the cars themselves have been so plentifully illustrated, that I do not propose to occupy your time by showing you views with which all must be quite familiar.

It has been mentioned that a large proportion of the cars were of one general type. Of the thirty-eight cars entered, twenty-four, or 63 per cent., were of the live axle type, driven by a fore and aft propeller shaft and bevel wheel on the differential gear on the axle, as used by Renault in 1899. Some of these cars showed on examination that they had been designed in arrangement and detail, and carefully thought out on paper before they were put into the shops. Some, however, were very like a type of car not at the trials, which does no one any permanent good. The requirements for the design of this latter type of car are few. They are principally a component catalogue and an order form book; and the design is carried out by two things, namely, a handyman, erector, and a glossary of French and English terms. Cars designed in this way show themselves by numerous details, such as connecting-rods bent to escape things not noticed in the component catalogue, but which come in the way; lugs in various places that are not wanted or are not used; corners filed off to make way for something unforeseen; tanks in no way suiting the shape of the place they are made to take; disproportion of engine and cooler, of engine and gear, of car and brakes, and complications and indirectness not necessary in a designed car.

Cars made up of bought components are, in some cases, at least equal to those made in great part by the sellers, the components of some makers being excellent in design and materials. There are, however, components on the market that ought never to be allowed to be put into a motor car. Generally, however, the cars at Hereford were of high class in design, and the average quality as good, or better, than that of the average big car. Very few 12 or 15 horse-power cars would mount Frome's Hill in the style and at the speed that the 6, 6½ and 7 horse-power cars mounted it with two passengers. The mechanical apparent efficiency of some of the cars was very remarkable, and it is worth while considering some of the particulars of their performance.

The speed of the ten fastest cars on Dinsmore Hill and on Frome's Hill up to the point at which the gradient became more than 1 in 7, was as given in the following table, which also gives the deduced efficiency. To determine the mechanical efficiency, a road resistance of 50 lb. per ton has been taken, and the air resistance r has been calculated by the expression

$$r = V^2 A\, 0{\cdot}0017,$$

A being the area presented to air resistance in square feet, and V = velocity in feet per second.

TABLE I.—*Mechanical Efficiency of Ten Fastest Hereford Cars.*

No. of car. In order.	Official.	Name.	Declared B.H.P.	H.P on hills.	Mechanical efficiency.
1	10	Wolseley	6·5	5·61	86·25
2	22	De Dion	6·0	5·19	86·40
3	14	Swift	7·0	5·12	73·20
4	15	Star	7·0*	5·42	77·50
5	18	Siddeley	6·5	5·16	79·40
6	20	Wolseley	6·5	4·75	73·10
7	26	Swift	7·0*	5·30	75·75
8	30	Croxted	8·0*	5·63	62·69
9	38	Star	7·0*	5·74	82·00
10	23	De Dion	6·0	4·24	70·75

*Two cylinders.

It may be said in criticism of these figures of mechanical efficiency that the brake horse-power used for comparison with the horse-power represented by the work done in hill-climbing is an uncertain quantity, as only being the brake horse-power declared by the makers. I have, however, checked the horse-power, which it is possible to do with a very near approximation to accuracy, from the engine dimensions and speed, and would, moreover, point out that some of the Hereford hill-climbing was such as would find out, on the one hand, any brake horse-powers of the snatch test kind, while the 600 miles consumption test, if not absolutely accurate in each individual case, formed in the aggregate a good check on under-statement of brake horse-power.

Taking, then, the mechanical efficiency as found with a road resistance of 50 lb. per ton, it will be seen that they are remarkably good as compared with the results of previous trials and as compared with the results of the dynamometer trials conducted under the auspices of the Automobile Club of France, about four years ago, by M. Forest and others. They show an advance, which, in round figures, may be taken as from 65 to 80 in the last four years, or an increase on the figures of 1900 of at least 20 per cent. The ten highest efficiencies are not confined to one class of transmission gear, four types being represented, and the three highest represent three distinct types, namely, Wolseley, De Dion, and Star. Three of the fourth type, namely, the two Swifts and Alldays, come next, and although a good deal lower than the Wolseley and De Dion, are consistent approaches to similarity for the same class of drive, namely, the bevel drive on a live axle.

That the system of transmission is very far from being an index of performance is, however, shown by the difference in that of the two Wolseley cars and the two De Dions, a difference which was as noticeable in the "go" of the cars during the trials as in the difference in mechanical efficiency deduced from them. Such a difference as is shown by these two cars must show how very much performance by a particular class of mechanism may be affected by what may be called workshop differences which are difficult of detection. The difference, it will be noted, is not so great between the performance of the Wolseley and Siddeley cars as with the two De Dions. They also show how very unwise it may be to send a car which has not been run long enough to give opportunity for complete adjustment and run by the same driver for trial.

The highest mechanical efficiency is not always accompanied by the most economical performance. Thus the ten cars showing the highest mechanical efficiency change positions with regard to economy into the following order:—

TABLE II.—*Relative Economy of Ten Fastest Hereford Cars.*

No. of car. In order.	Official.	Name.	Miles per gallon.	Total weight with passengers. lb.
1	14	Swift*	33·3	1512
2	18	Siddeley	32·5	1603
3	30	Croxted	32·3	1848
4	22	De Dion	30·3	1414
5	23	De Dion	30·3	1414
6	15	Star	29·5	1694
7	10	Wolseley	28·3	1596
8	38	Star	25·4	1908
9	20	Wolseley	24·6	1554
10	26	Swift†	23·6	1610

* One cylinder. † Two-cylinder.

Several cars, not included in the ten fastest and of highest apparent mechanical efficiency, were among the most economical, namely, the Clyde, with 47·2 miles per gallon, a result which seems to show some error in the petrol account, which, however, could not be detected; the 6½ horse-power Royal Humberette, with 37·9 miles per gallon; Alldays 7 horse-power, with 34·5 miles per gallon; Alldays 7 horse-power, total weight, 1533 lb., with 33·3 miles; 8 horse-power Brown, with 31·4 miles; the 6 horse-power Jackson dogcart, total weight, 1330 lb., with 28·5 miles; Prosper Lambert, 8 horse-power, total weight, 1890 lb., with 27·2 miles; and the 6 horse-power Speedwell, total weight, 1309 lb., 25·8 miles.

With regard to transmission gear, one of the cars which commenced the trials but had a mishap breakage, namely, the Downshire car, presents a point of some interest with respect to chain stress. The chain used runs from engine shaft to gear on the live axle. The lower speeds are effected by change of gear driven by the chain and not by gear driving it. The pull on the chain is therefore not increased with the lower speed gear in use, as in arrangements adopted in some other cars with a single chain, in which the speed change is made in the gear driving the chain.

All examination of the economy figures will show that there cannot be any doubt that in many cases consumption is a function of the skill and constancy of attention of the driver. It may, however, be noticed in passing that while the two De Dion cars, differed considerably in apparent mechanical efficiency, their consumption was identical, while the two Wolseleys, which differed so much in apparent mechanical efficiency, differed in the same order in consumption, which would seem to indicate similar care on the part of the drivers in this respect.

There seems to be very little relation, as has often before been observed, between vibration and noise and economy. Vibration more often can be detected as running in partnership with noise, but this is very far from being general. Vibration may, in fact, often be accompanied by excellent workmanship and freedom from looseness of parts. In such cases it is due sometimes to want of attention to balance of parts, to weight of the reciprocating parts, to inequality of turning effort, and to insufficient fly-wheel. As bearing on this latter part of the subject, I have prepared a diagram, Fig. 1, which may be of some interest. For convenience this diagram is in two parts, but it may be supposed that the lower part follows on the right-hand end of the upper part. It represents the four strokes of the one-cycle of one cylinder. The lightly-shaded part bounded by the line A of the firing stroke is the area bounded by the pressure curve of an ordinary indicator diagram from a petrol engine running at a rather low speed. On the next, namely, the exhaust stroke, this line falls to very near the atmospheric line O, and for the greater part of its length nearly follows it. In the third stroke, namely, the suction stroke, the indicator diagram line A may be seen at some distance below the atmospheric line, and continues to be so during the commencement of the compression stroke. The compression stroke, curve A, then rises to the point shown by the rapid rise at the end of the diagram.

By setting out the four strokes of the cycle in series in this way we may trace the effects in each stroke of the inertia and momen-

tum of the reciprocating parts. In the ordinary diagram, taken during the four strokes, the compression area is deducted by the indicator from the firing stroke, although the deduction does not, of course, occur during that stroke at all. The true area of the pressure diagram is, therefore, as seen in the firing stroke in the diagram, Fig. 1. We have, however, to deduct from the first part of the stroke the area B, which represents the pressure required for acceleration of the piston and connecting-rod during half stroke, or rather less than half stroke, in consequence of the angularity of the connecting-rod. Correspondingly, we have to add to the latter part of the ordinary pressure diagram, the double shaded part C, which represents the pressure due to the inertia of motion of the reciprocating parts, or the work done on the crank pin during the retardation from maximum to zero velocity of linear motion of the piston.

The sum of the positive and negative quantities due to the same diagram the plus and negative turning efforts on the crank pin are shown by the curve F, which, for convenience, is shown to a much heavier scale of pressures than the other curves.

In this the great alternations, not only from maximum pressure during the working stroke, but from plus to minus pressures that occur in the other strokes, are shown. It will be noticed that a little beyond the half stroke on the exhaust the pressure changes from a heavy one on the rod, back to a pull on the rod cap brass, and the same thing occurs on the suction stroke. To many, no doubt, the most notable feature of all will be the curve of the compression stroke, which shows a gradually decreasing negative work pressure on the crank and connecting-rod, and that this becomes least as the compression approaches a maximum, the momentum of the parts doing the compression. A very little consideration of this diagram will show on the one hand how important is

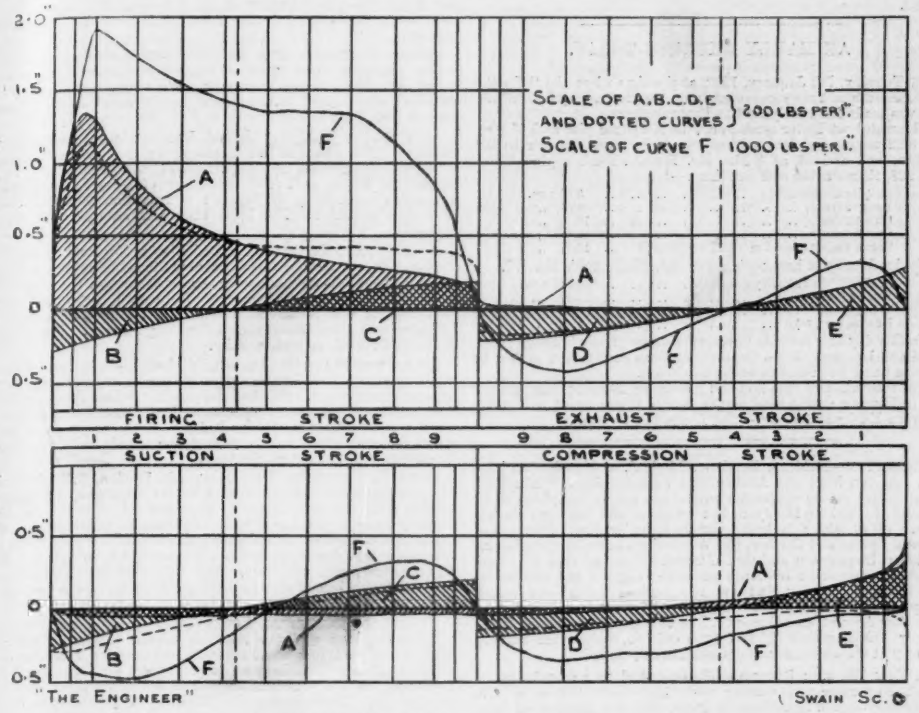
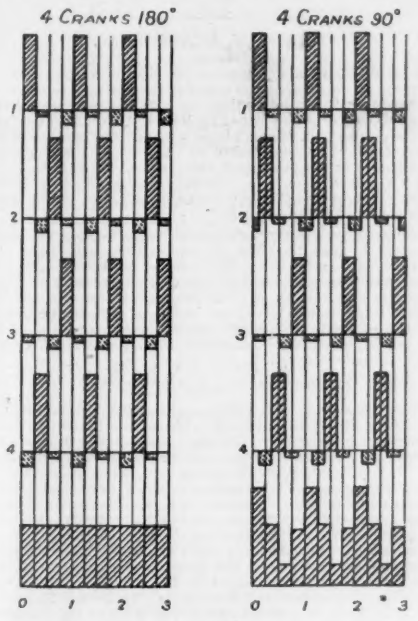


Fig. 1—PRESSURE-INERTIA DIAGRAMS

pressure of the combustible charge, and the minus and plus effects of inertia of parts, gives, therefore, a modified form to the upper boundary of the diagram, and this is shown by the dotted line diagram. The negative work at the beginning of the exhaust stroke is as great as that at the commencement of the firing stroke, and a diagram showing the area representing it, shown at D, and the work to be done by the strap or bolts at the end of the connecting-rod, at the beginning of the suction stroke, is seen to be very considerable, the pressure necessary to accelerate the parts being as great as that shown on the negative side of the firing stroke. The same positive and negative inertia work areas



COMPARATIVE TURNING EFFORTS

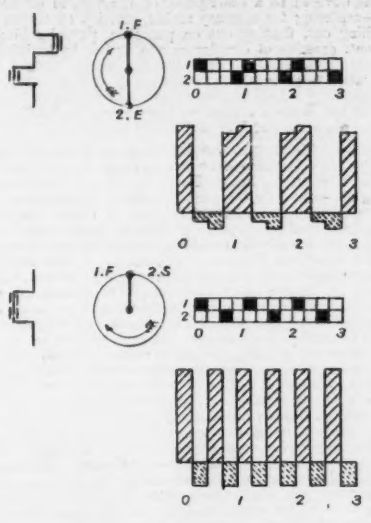
"THE ENGINEER"

Fig 2

are also seen in the compression stroke, in which, in the case taken, the inertia of motion or momentum nearly equals the compression work. The whole of the momentum, then, of this half stroke is converted into stored energy, which will be utilised in the next stroke, but from the moment the exhaust stroke commenced the accumulated energy of the fly-wheel has been called upon to keep the engine and machinery going.

Those concerned with the engines that run at 1500 and 2000 revolutions per minute should plot this diagram for those speeds, and they would then not wonder why big end bolts and brasses are not strong enough, nor would they wonder why it is that some engines reach their useful speed sooner than others, or why cranks and connecting-rods have broken most often at a time when the work being done was apparently very far from a maximum. In sufficient fly-wheel weight, and on the other hand how great is the alternation of stress thrown on the crank, and what the effect may be in a heavy car when a fierce clutch is dropped in by the foot slipping off the pedal, especially on a steep down grade. The turning effort curve further shows—and here is the point of this digression—wherein lie the causes of vibration.

There were not many two-cylinder engines in the Hereford cars, but reference to them directs attention to an important question with reference to the design of cranks for two or more cylinders. All cranks are subject to ambiguous stresses, even that of the ordinary single-cylinder engine, but the common double crank of the Z form is mechanically bad. The single-throw crank for two cylinders is bad, though it gives a better sequence of cycles, and it is not so easy to balance. The sequence, however, though it gives a more equable turning moment, is not considered so good in practice, because a periodic succession of efforts, though with a longer interval, is sometimes more useful in getting away, or nursing over short hills. The diagram—Fig. 2—shows the com-



SEQUENCE OF CYCLES

"THE ENGINEER"

Fig. 3

parative turning effort and sequence of cycles with the two forms of double-cylinder cranks, the upper diagram being, of course, the same as if the crank were of the Z pattern. The upper diagram for each crank shows the sequence, and the lower diagrams the sum of the plus and minus efforts, with the time lapse between them. Fig. 3 shows the comparative turning effort in the same manner, with two arrangements of sequence with four cylinders. The stresses on the Z crank are enormously greater than in the crank with a bearing between the two cylinders, and the space lost by placing the two cylinders so close together that there is no room for a central bearing cannot properly be of such value as to be of comparable importance. A look at a diagram of a crank of this type will, with a few words, supply an explanation to this condemnation of the Z crank. The long arm between the two cranks has to receive an impulse in one direction, and without any fulcrum to convert it into motion in the opposite direction of the crank pin to which it is attached. I will not trouble you now with a proof of the nature of the stresses in this Z crank, but will merely say that it can be shown that the bending stress in the central arm is double that with a crank with the central bearing, and the torsional stress on the crank pin is many times increased.

I have spoken of disproportions in many of the cars now made. With regard to brakes and of one family of makers who are not makers, I may sum up the most obvious grounds of criticism by saying, first, that when they begin making cars they should remember that they are not making perambulators; and secondly, that the stresses in brake bands and brake connections are inversely proportional to the diameter of the brake drums.

Another disproportion which is very striking is in the proportions and size of the coolers or radiators. The accompanying table gives approximately the number of square feet of tube surface in the coolers of a number of the Hereford and other cars. The first column of this table neglects the surface of the gills, which are put and sometimes soldered on the tubes. These gills have much the same effect in a large proportion of the coolers, so we may at first deal only with the tube surface as proportional to the whole. It will be seen that this varies from 0·23 square feet to 0·86 square feet per declared horse-power of the engine. Now, they cannot all be right, and, therefore, some of them must be very much too small, and others must be too large. The largest surface will be required when the car is standing, or on a long hill, and when the wind is behind the car, but we must in all cases make the cooler proportional to the power of the engine. A very little calculation will give the basis on which the requirements of a cooler in the usual position may be determined.

COOLERS.

Approximate Cooling Surface. In Order of Surface of Tubular Surface.

	H.P.	No. in trials, 1904.	Tube surface per h.p.	Tube and gill surface per h.p.
Rover	8	33	0·230	1·61 (fan)
Prosper Lambert	8	37	0·234	1·87
Civil Service	9½	7	0·251	2·01
Jackson	6	4	0·270	2·16
Croxted	8	30	0·331	—
Alldays	8	32	0·351	2·10
Star	7	7	0·490	3·42
Swift (single-cyl.)	7	14	0·507	4·06
Swift	7	26	0·535	4·28
Speedwell	6	2	0·594	4·73
Speedwell	9	13	0·602	4·81
Chambers	7	19 (plain tubes)	0·675	0·67
Enfield	8	27	0·685	5·48
Humber	7½	34	0·737	4·42
Siddeley	6	18	0·800	4·80
De Dion	6	22 and 23	0·816	0·81
Wolseley	6	10 and 20	0·820	5·00
Mobile	6	11	0·862	7·73
Brown	8	12	2·100	2·10

One actual horse-power of the engine of mechanical efficiency, E, represents—

$$\frac{\text{H.P.} \times 33{,}000}{\text{J} \times \text{E}}$$

J being the mechanical equivalent of one thermal unit. The thermodynamic efficiency, Te, of the petrol engine being far below unity, the total heat to be considered with reference to 1 horse-power is much above that represented by the heat equivalent of the foot-pounds of work done, and is—

$$h_1 = \frac{\text{H.P.} \times 33{,}000}{\text{J E Te}} \left[1 - (k + h_2 + \text{Te})\right]$$

Of this a quantity k goes away with the exhaust, leaving a remainder $h_1 + h_2$ units to be carried off by the cooling water and by radiation and conduction respectively per minute per horse-power. This gives us, then, as the heat units to be provided for and carried off by the cooler—

$$\frac{1 \times 33{,}000}{777 \times \cdot 90 \times 0 \cdot 165} \times 1 - (0 \cdot 40 + 0 \cdot 13 + 0 \cdot 165) = 86 \text{ B.T.U.}$$

Taking the maximum desirable temperature of the jacket water as it enters the cooler as 160, and the temperature as it returns to the jacket as 120 deg., we have a difference of temperature of 40 deg., so that a minimum of 2·15 lb. of water must pass through the cooler per minute, assuming every drop of this water to be raised from 120 to 160, and every drop lowered to 120 by radiation, &c. The rate, however, at which heat is transmitted when the temperature difference is small is very low, and a much larger quantity of water must be passed through the cooler, although the thermal work to be done remains the same, and cooler tube surface must be large enough to carry off this heat under normal conditions of air temperature, a low speed of the car, or a normal speed of air as helped by a fan.

Taking the average of a large number of experimental determinations of the quantity of heat which can be carried off by a unit surface, it is found that in still air 0·036 units will be carried off per minute per square foot per degree difference in temperature. Air at 10 miles per hour will carry off about four times the quantity of heat that will be carried off by still air at the same temperature. At that speed in miles per hour, and an air temperature of 60 deg., then we shall require about

$$\frac{86}{(160 - 60) \times \cdot 0362 \times 4} = 5 \cdot 9 \text{ square feet per horse-power.}$$

Now, assuming that the rate of circulation of the water in the cooler is such that the receptive capacity of the material of the cooler tubes is approached, and that the emissive power of the tube surface under these conditions can be usefully increased, as experiment suggests, by six-fold, then the tube surface necessary per horse-power will be about one square foot, the useful surface of the gills being about five square feet. A few of the cars reach this requirement, but many are below it. No wonder that some engines will run hot. Many cars have a tank in addition to the cooler, even when the cooler has connected reservoirs; but these tanks are often placed in a warm place under the bonnet and next the dashboard, so that they cannot help much in the cooling. Again, many of the coolers have tubes with several rows one behind the other, so that they live in a nice warm atmosphere, heated by the tubes in front of them, and so that the temperature difference between them and the air passing them is small, and this renders them comparatively ineffective.

Some of the Hereford cars were fitted with plain tubes without gills of any kind, and although their surface was less than that which seems necessary by calculation, they appeared in most cases to be sufficient. But these tubes were all so arranged that the air had very free access to them, none of the tubes being so placed that they were kept warm by their close contiguity, by air obstruction, or by being kept warm by those in front of them. Honeycomb coolers have in most cases a very large tube surface per horse-power, but in almost all cases the surface is less efficient than it might be. Generally, about half the surface would be sufficient if the tubes were a little larger, so that the air could go through them more freely—a little wider apart, so that the water passing per unit of time over unit surface were increased, and somewhat shorter, so that there could be a useful difference in temperature throughout the tube between air and tube surface.

Of the thirty-eight cars entered for the Hereford trials, there were eight with horizontal engines, of which five were of British make and three American. Three of the English were of one make, and of what is known as slow speed, and all these cars did well in the trials, as the cars of the same makers have done previously in the longer trials. The number of horizontal engine cars was 21 per cent. of the whole, which is a notable proportion, in view of the prejudice which has been expressed against this type of engine. Considering its accessibility in the simple form of

the small car engine, its use may be expected to increase, especially with some of the most used forms of chain transmission. As between a vertical and a horizontal engine there is very little ground for preference. It may be said, as has already been said about a totally different subject, that one is as good as the other and a good deal better according to circumstances of environment.

All the Hereford cars were fitted with high-tension coil and sparking plug ignition apparatus, and remarkably few stoppages occurred in consequence of ignition defects. Most of them were, in fact, confined to two cars, and the experience of the trial confirms that of those automobilists who prefer this system to any other. There is much to be said for a system that successfully uses the sparking plug in preference to a sparking device requiring a moving part in the cylinder. The low-tension and the high-tension magneto machines introduce a separate working part, although the high-tension form retains the sparking plug. It may, however, be hoped that a simple form of magneto involving no rotating parts not already wanted—for instance, the fly-wheel—may be forthcoming; something, for instance, of the kind introduced at the 1903 trials on the Albion car, but it must be of a simple order, and must use a fixed sparking plug.

Of the kinds of circuit make-and-break shown on the Hereford cars, it may be remarked that the very simple, though crude, form used on the American cars is capable, with very slight improvement in carrying out, of being made very satisfactory for the moderate-speed engines, and by merely enlarging the wipe contact cylinder it will easily be made quite effective for high-speed engines. There are few of the details of a car, more especially of the larger sizes, concerning which recent "advances" have gone so far backwards as in the apparatus of the circuit make-and-break.

NOTES FROM SOUTH AFRICA.

(*From our own Correspondent.*)

JOHANNESBURG, November 14th.

THERE can be now no doubt that the steady improvement induced in the mining industry, owing to the increased supply of suitable unskilled labourers, has at last begun to make itself felt in commercial circles. Business is certainly improving, and if the over-confidence which has on previous occasions of promise led to the glutting of the local market can at this juncture be restrained, there is every reason to anticipate the establishment and continuity of a state of healthy activity. The local Press does not tire of sounding this necessary warning note, and it is to be earnestly hoped that business men will proceed cautiously.

On the 15th inst. the Inter-colonial Council will hold an extraordinary meeting at Bloemfontein, and the matters to be discussed are of the greatest importance, not only to the Transvaal, but to the whole of British South Africa. It will be remembered that the large schemes of railway extension, which it was intended should be undertaken by the joint Government and with the joint credit of the two new Colonies, had to be laid aside some few months ago, owing to the delay that the native labour shortage had occasioned in the return to the pre-war mining activity, and to the consequent deficiency in the estimated Transvaal State finances. This was a great blow to the hopes of advancement, and no efforts have been spared by those who have the welfare of the country at heart to arrange in some way or other for the carrying out of the programme of new construction. Good fortune has attended their labours, as the following extracts from the agenda for the forthcoming meeting of the Inter-colonial Council will show:—

Draft agreement with the Government of Natal for the construction and working of a line of railway from Bethlehem to Kroonstad.

Draft agreement with the Government of the Cape Colony for the construction and working of a line of railway from Aliwal North to Wepener, and an extension from Wepener to a junction Marseilles-Maseru or Thaba 'Nchu-Modderpoort line.

Draft agreement with the municipality of Ladybrand for the construction and working of a line of railway from Modderpoort to Ladybrand.

Draft agreement with the municipality of Fauresmith for the construction and working of a line of railway from Jagersfontein to Fauresmith.

Consideration of question of construction of a line of railway from Bloemfontein to Kimberley.

Authorisation for work to proceed on a line of railway from Krugersdorp westwards.

Draft agreement with guarantors for the construction and working of a line of railway from Springs to Witbank.

Draft agreement with Messrs. Mordey and Dawbarn for the electrification of the Springs-Randfontein section of the Central South African Railways.

Regarding this last item, it may be stated that it refers to the local line, 58 miles in length, running along the reef from Krugersdorp, through Johannesburg and Germiston to Brakpan, and thence to the Springs coalfield. In an interview described in the *Transvaal Leader* to-day, Mr. T. R. Price, C.M.G., the general manager of the Central South African Railways, gives some interesting particulars. It appears that Messrs. Mordey and Dawbarn, who are now advising the Johannesburg Municipality in connection with the new town tramways, are in this instance the agents of, as well as the consulting engineers to, the department of the Central South African Railways. In their first-mentioned capacity they have entered into a provisional arrangement with an English-American firm, who will supply all British material for the electrification of the local railway. The system proposed is the single-phase system, the current to be carried by an overhead wire at the side of the track. A special power station, with a complete generating plant, will probably be set up at Germiston, this site being preferred as the most suitable and central, bearing in mind the possibility of the traffic with Pretoria growing to such an extent as to warrant the electrification of that section as well. It is not considered necessary to purchase entirely new rolling stock, for, under the arrangements that are contemplated, the present suburban carriages, with certain modifications, will be utilised for the electric traction service. It is not contemplated to haul the coal and other heavy traffic by electric power; but later on, if it is found to be more economical to do so, steps will be taken in that direction.

Turning to mining matters, it should be recorded that the confidence created in the tube-mill, as an agent for the ensuring of an improved gold extraction—and, therefore, of higher profits—continues unabated. The tube-mill at the Glen Deep Gold Mining Company has now been running on a trial of silex lining for two or three weeks, and the wearing qualities of the new material have been very favourably reported upon. The mill is now dealing with the coarse product—separated by spitzlutte, and amounting to about 120 tons per day—from the whole battery of 100 stamps, and a more rapid, as well as a more efficient, extraction results. The lining is made of rough trimmed blocks of natural silicious rock, 6in. by 4½in. by 2½in., cemented in place. Up to the present there has been no loosening of the blocks, and the wear is slight.

In the issue of 15th July—page 71—were given a few details of the Robinson deep cage disaster, and mention was made of the fact that the resident engineer of the mine was to be charged with culpable homicide. The trial came on at the Criminal Sessions, Johannesburg, on the 3rd inst., and lasted two whole days. It resulted in the acquittal of the engineer, the principal reason for the verdict of "Not Guilty" being, no doubt, the conclusive evidence produced at the trial, that the winding rope had been regularly examined in accordance with the usual customs obtaining in these mining fields. This, naturally, has raised the question as to whether the practical examination of a hauling rope, as carried out daily on the Rand, is any real security for the safety of persons who are raised and lowered by means of ropes. The proposal has even been made in the Press that the Government should undertake the inspection of these ropes, in a somewhat similar way to that now in vogue in the case of a steam boiler.

The mining regulations are to be amended so as to make it compulsory in the case of a rope that is used for rock haulage, as well as for the conveyance of persons, that the maximum working load—including weight of suspended rope—in the latter instance shall not exceed 0·85, the maximum load on the rope when rock or ore is being lifted. The majority of winding ropes in use on the mines of the Rand are used for both purposes, and considerable confidence will be created by the reflection that ropes which carry large loads of rock at high speeds are reasonably safe when carrying lighter loads of persons at reduced speeds. This proposal for the amendment of the law is quite in keeping with the general practice on these mines; the Robinson Deep case was, however, one of the very few exceptions, for, when the fully loaded three-decker cage was attached below the empty skip, the statical load was then about 1·2 times that obtaining when mineral was being raised.

AN EARLY EXPRESS TRAIN.

ON Tuesday, 7th January, 1862, at the time when the "Trent" despatches were hourly expected from America, a very fast railway run was made from Holyhead to Euston-square.

The mail boat Ulster came to rest at Holyhead pier at 8.15 a.m. At 8.22 engine Cerebus worked the train from the pier to the station, and arrived at 8.26. Mr. Ramsbottom's engine Watt, No. 229, then started and ran thus:—

Holyhead (depart)	8.28 a.m.
Bangor (pass)	8.57 ,,
Chester (pass)	10.5½ ,,
Crewe (pass)	10.28 ,,
Trent Valley Junction, Stafford (arrive) ..	10.53 ,,

Engine Watt was here replaced by Mr. McConnell's No. 372.

Stafford, Trent Valley (depart)	10.54½ a.m.
Rugby (pass)	11.41 ,,
Tring (pass)	12.41 p.m.
Euston (arrive)	1.13 ,,

To this day this remains the finest run ever made between Holyhead and London. From the arrival of the boat to the arrival at Euston being two minutes under five hours.

The load was two vans and one saloon, or 20 tons; but against the train was a strong wind on the North Wales coast, and a fog between Kilsby and Tring.—*The Locomotive Journal.*

CONTRACTS.—Meldrum Brothers, Limited, of Manchester, have just received from the Admiralty a contract for a "Simplex" regenerative refuse destructor with steam generating plant, to be erected at Chatham Dockyard in connection with the large electric power plant which is being installed under the directions of Messrs. Preece and Cardew, the Admiralty's consulting engineers. —Robert Stephenson and Co., Limited, inform us that they have received an order for ten large passenger engines and tenders for the Shangai Nanking Railway, the engines being four wheels coupled, with leading four-wheel bogie with six-wheel tenders.—The Hart Accumulator Company, Limited, has received an order to supply 110 Standard lighting type cells to replace the existing battery at the electricity works, Southwold, Suffolk.

A NEW TURNING RECORD.—We described in a recent Supplement, November 4th, dealing with high-speed lathes, a 30in. electrically-driven lathe built by Hulse and Co., Limited, of Manchester. This lathe has now been put to serious work, and has undoubtedly established a new record for high-speed turning. We are indebted to the makers for the following remarkable figures:—The work turned was a 20in. steel shaft; four tools were used, each cutting 1¼in. deep with a ¼in. feed at 44ft. per minute. The spindle made 8·4 revolutions per minute, and the gear ratio—the first quintuple—was 34·87. The cubic inches of metal removed per minute amounted to 594, or 35,640 per hour, which is equivalent to about 168 lb. per minute, equal to a rate of over 4½ tons of steel removed per hour. It is not, under the circumstance, surprising to hear that "two labourers are employed day and night in removing the cuttings."

INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE STUDENTS' ASSOCIATION.—The second ordinary meeting of the above Association was held in the Law Institute, Leeds, on Thursday, December 1st, when a paper was read by Mr. J. Husband, A.M.I.C.E., on "The General Design and Erection of Bridges." Mr. Husband discussed first the considerations affecting the choice of design—physical characteristics of site, demands of navigation, material, amount and rapidity of transit of travelling load, rigidity, exposure to wind, possible methods of erection, &c. The second part of the paper was devoted to a description of the various methods of erection—centering for masonry arches, erection on timber falsework, rolling out, floating out on pontoons, partial rolling and floating out, erection of cantilevers and arches by building out, lifting bodily into place, rolling bodily into place. Special attention was called to the æsthetic treatment of bridges. The paper was illustrated by a large number of slides, including photographs of most of the modern bridges of large span. A hearty vote of thanks was passed to Mr. Husband for his paper.

THE JUNIOR INSTITUTION OF ENGINEERS.—There was an exceptionally large attendance at the meeting of this Institution held at the Westminster Palace Hotel on the 3rd December, the chairman, Mr. Samuel Cutler, jun., M.I. Mech. E., presiding, when a paper, entitled "Some Points of Interest on Torpedo Boat Construction," was read by Mr. H. E. Yarrow, Stud. Inst. C.E., of Poplar. Commencing with considerations with respect to the hull, the author showed the importance of realising in the design the maximum strength with the minimum weight, uniform elasticity throughout its length being essential. Any sudden change of section in these lightly-constructed vessels formed a source of great danger, and it was quite possible, by adding material, to reduce the actual strength. Passing on to questions with regard to riveting, hot *versus* cold riveting processes were discussed, the latter being advocated as possessing advantages over the former. In the best work the holes were drilled in preference to being punched. It was of great importance to minimise vibration as much as possible, and the author illustrated by means of lantern slides the effect of a properly-balanced engine on the stability of the boat itself. The superiority of a four-cylinder as compared with a three-cylinder engine in this respect was indicated. The necessity of more attention being given to the design of auxiliary engines was commented upon, and considerations in regard to lubrication were entered into, the author insisting that all internal lubrication should be dispensed with absolutely, both in the main and in the auxiliary engines. No real difficulties occurred in this, and the good results on the working of the boilers were obvious. With the use of high-pressure steam the paper showed how imperative it was specially to consider the best practice relating to steam pipes; those of small diameter being recommended for various reasons, amongst them being superheating of the steam, and ensuring that each boiler was developing approximately its proper proportion of the power required. Referring to steam turbines, the author held that, although they possessed many advantages over reciprocating engines, they could not be regarded as economical for varying speeds, as in torpedo boats. He alluded favourably to the explosive type of engine, which was developing so rapidly at the present time. It presented many characteristics specially advantageous to its adoption in the class of boat under consideration, including elimination of the boiler-room staff, and general reduction of weight. An animated discussion followed, in which Messrs. C. A. Smith, C. D. Bell, C. J. McNaught, H. J. Fraser, G. C. Allingham, W. J. Tennant, F. W. Dunn, R. Marshall, and the chairman took part; and the proceedings closed with the usual vote of thanks.

CATALOGUES.

RHODES ELECTRICAL MANUFACTURING COMPANY, Limited, 70-71, Bishopsgate-street Within, London.—Leaflet giving particulars of the outputs and prices of R. E. type electric motors with different frames and speeds.

GENERAL ELECTRIC COMPANY, Limited, 67-71, Queen Victoria-street, London.—This is a neatly-produced little pamphlet, No. E 1071 on electric radiators, of which illustrations of some very tasteful designs are given.

SUN FAN COMPANY, Limited, Longside-lane, Bradford.—We have received from this firm copies of new catalogues of propeller and centrifugal fans both for belt driving and direct-connected electrical operation. Capacities and prices are given.

MATHER AND PLATT, Limited, Manchester. Polyphase generators is the subject of the second edition of a little book just issued by this firm.—The generators are of the revolving field type with a stationary armature, and are arranged for coupling direct to engines.

ERITH'S ENGINEERING COMPANY, 70, Gracechurch-street, London. —The Cochrane open type of feed-water heater and purifier forms the subject of this catalogue. We understand that these machines have already been adopted to the extent of 2½ million horse-power.

ACME ENGINE COMPANY, Limited, Budhill-avenue, Shettlestone, Glasgow.—The catalogue issued recently by this company contains a very full description, with illustrations of the Acme engine, and, besides, is issued with the endeavour of correcting any false impression respecting the amount of attention that this class of engine requires. The little book will be read with much interest.

DAVIDSON AND COMPANY, Limited, Sirocco Engineering Works, Belfast.—A new catalogue has been produced describing Sirocco machinery suitable for tea estates. It contains all the necessary plant for the treatment of tea from the time it is plucked until it is finished and packed in chests. From the above it will be gathered that the contents form interesting reading. The get-up of the little book is praiseworthy.

BRUCE PEEBLES AND CO., Limited, Edinburgh.—A new pamphlet—No. 6—just published by this company contains an interesting illustrated description of the Peebles self-propelled steam railway car. The chief feature of the motive mechanism is the use of a light high-speed engine hung from the underframe of the car, which drives one of the axles through spur gearing, two speeds being provided. The boiler is of the water-tube type.

PETER BROTHERHOOD, Belvedere-road, London, S.E.—The air compressing machinery illustrated in the catalogue, just issued by this firm, has been specially produced to meet the requirements of users of pneumatic tools and other apparatus using air under high pressure. In preparing the designs of each type of compressor, the first importance has been given to securing the highest commercial efficiency. The book contains sectional and general illustrations of various patterns of plant, and is produced in excellent style.

HUMBOLDT ENGINEERING WORKS COMPANY, Kalk, near Cologne. —From this firm we have received several catalogues, dealing respectively with reducing machinery, ore dressing and magnetic separation, bridge building and constructional work, apparatus for unloading coal and ores from ships, and testing plant for crushing and dressing. The last-named is fitted up in the works at Kalk, and is open to make tests of materials under the strictest secrecy for clients. It should be stated that in the production of all these books expense has not been stinted.

VERITYS, Limited, 31, King-street, Covent-garden, London.—The new catalogue of electric supplies, department I. and II., will be found particularly useful to those engineering firms who have their own staff, and only require to purchase electrical material. The publishers have endeavoured to group systematically in the catalogue everything likely to be wanted by any engineering firm in connection with electrical material. It may be observed that there are eight sections, each of which is identified by a letter, and this again appears on every page of the particular section. A subsidiary index is given on the title-page of each section, showing the page numbers of the different headings in that section. A comprehensive index is also provided, including everything in the book.

ALMANACS, DIARIES, &c.

WE are reminded of the approaching close of another year by the receipt of several almanacs and diaries. Nothing better could be desired in colour printing than the excellent specimens shown on the two wall calendars issued by Messrs. Arthur L. Gibson and Co., Tower-street, St. Martin's-lane, London. The selection of the subject of the "Country Blacksmith" is a happy one. Another wall calendar in the printing of which equally good taste is displayed is that of Wm. Augs. Gibson, Limited, 28, Fleet-street, London. For hydraulic engineers the selection of an old water-driven mill is highly appropriate.

The Gloucester Railway Carriage and Wagon Company, Limited, has issued in good time the well-known Gloucester Diary and Directors' Calendar for 1905. This has now reached its tenth year of issue, and it has not been found necessary to introduce any new features in next year's book. Messrs. Clarke, Chapman and Co., Limited, Gateshead-on-Tyne, are issuing a self-opening pocket diary and note-book, with £1000 accident insurance coupon. This book will be found highly acceptable by all who are fortunate enough to receive a copy.

ROYAL INSTITUTION.—The following are the lecture arrangements at the Royal Institution before Easter:—A Christmas course of lectures—experimentally illustrated and adapted to a juvenile auditory—on "Ancient and Modern Methods of Measuring Time," by Mr. Henry Cunynghame; Professor L. C. Miall, Fullerian Professor of Physiology, R.I., six lectures on "Adaptation and History in the Structure and Life of Animals;" Professor Karl Pearson, three lectures on "Some Recent Biometric Studies;" Professor W. E. Dalby, two lectures on "Engineering;" Mr. A. H. Savage Landor, two lectures on "Exploration in the Philippines;" Mr. Churton Collins, two lectures on (1) "The Religion of Shakespeare;" (2) "The Philosophy and Significance of 'The Tempest';" Professor W. Schlich, two lectures on "Forestry in the British Empire;" Mr. J. J. H. Teall, two lectures on "Recent Work of the Geological Survey;" Professor H. H. Turner, three lectures on "Recent Astronomical Progress;" Professor R. Meldola, two lectures on "Synthetic Chemistry (Experimental);" Sir Alexander Mackenzie, three lectures on the "Bohemian School of Music," with musical illustrations; Mr. D. G. Hogarth, two lectures on "Archæology;" Professor J. J. Thomson, three lectures on "Electrical Properties of Radioactive Substances;" and the Right Hon. Lord Rayleigh, three lectures on "Some Controverted Questions of Optics." The Friday evening meetings will begin on January 20th, when a discourse will be delivered by Professor Sir James Dewar on "New Low Temperature Phenomena." Succeeding discourses will probably be given by Dr. E. A. Wilson, Mr. Cecil Smith, Mr. J. W. Gordon, Professor H. Marshall Ward, Chevalier G. Marconi, Professor J. J. Thomson, Sir Squire Bancroft, Professor G. H. Bryan, Professor J. Wright, Professor T. C. Allbut, the Right Hon. Lord Rayleigh, and other gentlemen.—A general monthly meeting of the members of the Royal Institution was held on the afternoon of the 5th inst., Sir James Crichton-Browne, M.D., F.R.S., treasurer and vice-president, in the chair. Colonel C. W. Carr-Calthrop, Mr. Cecil Hanbury, Dr. E. Graham Little, Mr. Hugh Makins, and Mr. E. Reinach were elected members.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

EMPLOYMENT is more regular at the various engineering works, and in many cases employers are doing their best to find more occcupation than recently for the men before Christmas. There is still, however, a great deal of distress throughout the district, owing to employment in many trades being scarce. The machinery industries are fairly well engaged, alike on home and foreign account, and makers of contractors' tools are busier than they have been, whilst tools for colliery purposes are being produced in larger quantity than of late. Sugar machinery and accessories are in poor request, though some of the beetroot sugar factories are supplying small orders. Machinery and appliances connected with the cotton trade are in fair call. Shop tools are quiet. For gas and oil engines there is a good demand, both foreign and colonial as well as home.

There was a firm tone about 'Change on Thursday in Birmingham, and a cheerful feeling was prevalent. The revival in the iron trade continues, accompanied by good prospects. Lincolnshires were quoted in some cases up to 49s. 7d.; Northamptons, 41s. 6d. to 42s. 6d.; and Derbyshires, 43s. 6d. to 44s. 6d. Agents could for some brands book more business than they are doing, but they are chary about taking too much work on at present, since they expect values to go still higher. Staffordshire cinder forge is quoted 42s. to 42s. 6d.; part mine, 43s. to 45s. 6d.; all mine ordinary, 55s. to 60s.; and cold blast, 95s. to 100s., with a fair demand for the last named.

In the manufactured iron trade the strongest point has reference to galvanised corrugated sheets, which keep firm and dear, being quoted £10 10s. to £10 15s. f.o.b. Liverpool. Spelter remains dear. Plain sheets are in good request at:—Singles, £6 12s. 6d. to £6 17s. 6d.; doubles, £6 15s. to £7; and trebles, £7 7s. 6d. to £7 12s. 6d. Hoop iron is quoted £6 12s. 6d. to £6 15s. Several good contracts have been taken for gas strip at £5 17s. 6d. to £6.

In the steel trade British firms are doing better than for some months past, there being less American and continental competition to face. Bessemer billets are quoted £4 5s. to £4s. 7s. 6d.; Siemens, £4 10s. to £4 15s.; mild bars, £6 to £6 5s.; and girder plates, £5 17s. 6d. to £6.

A full meeting of the Wages Board is to be held on December 12th to consider the report of the committee upon matters connected with the Board's general working. The net average selling price for September and October has been returned as £6 3s. 9·11d. This is 1s. 2·42d. less than the preceding two months, but wages remain without alteration until February 4th, 1905, the rate for puddling being 8s. 6d. per ton, with millmen in proportion. The production was 27,499 tons, or an improvement of 2207 tons over the preceding two months. The production and price of the various descriptions making up the total were as follow:—Bars, 19,935, £6 3s. 8·64d.; angles and tees, 784 tons, £6 7s. 1·78d.; plates and tees, 1751 tons, £6 16s. 10·03d.; hoops and strip and miscellaneous, 5030 tons, £5 18s. 10·02d. That trade is very much weaker than it was this time a year ago becomes strikingly evident when the new total output and the new average selling price are compared with the corresponding figures for a year ago, such a comparison showing a falling off of 3857 tons in production, and a reduction of as much as 11s. 6·7d. in average selling price.

A new refuse destructor at Stourbridge, which has been provided at a cost of some £5000, has been started this week. It is a two-cell plant, and will deal with between 7000 tons and 8000 tons of refuse per annum. The Town Council of Dudley have decided to apply to the Local Government Board for sanction to borrow £21,000, which amount is needed by the Tramway and Lighting Committee to cover excess of and on account of expenses to be incurred for additional boilers, engines, dynamos, cables, and electrical plant.

"Motor Plants" is the title of a new company which has been registered with a capital of £10,000 to carry on business as motor makers and dealers.

Professor Turner recently delivered an instructive lecture before the Metallurgical Society at the Municipal Technical School on "The Hardness of Metals." Among methods for determining relative hardness, he recommended the Sclerometer, using a weighted diamond point—general application—the method of Brunel for mild steel and similar materials, and the drilling test of Keep for cast iron.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—It is again satisfactory to note a continuance of the strong upward movement manifested last week. The attendance on the Iron Change on Tuesday was exceptionally good, and more animation was perceptible than has been the case for some time past. The advance in pig iron caused more buying amongst merchants, and now that the cotton trade in Lancashire is stronger, there is more doing in the textile machinery department. We have heard of some contracts for finished iron being put through at the same rate as last year, but there is little disposition generally to book forward on the part of holders in any quantity. It is reported that German billets are being quoted at £4 8s. per ton f.o.b., which, if correct, should place English makers in a better position.

In pig iron more buying of Scotch has taken place on American account, and since Monday makers of various Scotch brands have made a further advance, so that there is every evidence that something like a "boom" is setting in in this important department of the iron trade. Lancashire brands of pig iron, however, do not seem to have followed in the same ratio as other makes. The advance of 2s. in Lincolnshire all round has been generally held, and Derbyshire and Staffordshire maintain their strong position, sellers only quoting in the meantime for comparatively small lots. Lancashire foundry No. 3 ranged from 52s. to 52s. 6d.; Lincolnshire, 51s. to 52s.; Derbyshire, 52s. to 53s.; Staffordshire, 52s.; Middlesbrough, open brands, 55s. 10d. to 56s. 10d.; Scotch, Gartaherrie, 56s. 9d. to 57s. 6d.; Glengarnock, 55s. 6d. to 55s. 9d.; Eglinton, 54s. 3d. to 54s. 6d., delivered Manchester. For delivery at the new port of Heysham, Gartsherrie ranged from 54s. 3d. to 54s. 9d.; Glengarnock, 53s. 3d. to 53s. 9d.; and Eglinton, 52s. to 52s. 6d. In forge iron there is little new to report. Lancashire, about 50s.; Derbyshire, 47s. to 48s.; Lincolnshire, 49s. to 49s. 6d., delivered Manchester.

There were better prospects reported in regard to finished iron, and with increased prices of raw iron makers are adhering to list prices. Lancashire and Yorkshire bars were generally quoted £6 5s.; Staffordshire, £6 5s. to £6 7s. 6d., delivered stations. Boiler plates, £6 17s. 6d.; hoops, £6 17s. 6d. to £7 2s. 6d.

The demand for constructional steel has been maintained, and one or two large orders have been placed with makers in this district. Local-made billets remain at £4 10s. to £4 12s. 6d.; steel bars, £6 to £6 2s. 6d.; angles, £5 10s. to £5 12s. 6d.; hoops, £7 5s.

Manufactured copper has had rather a quiet demand; sheets, £80 to £82 per ton; seamless copper tubes, 10d. per lb.; ditto brass, 8d.; rolled brass, 7¼d.; copper wire, 9d.; brass wire, 7¼d.

There was a fair attendance on the Coal Exchange, but trade was quiet generally. It was satisfactory to hear that the unfortunate dispute at the Astley and Tyldesley collieries has been settled, and the men have now resumed work. In the meantime the weather has caused a smaller demand for house coal, and there is little prospect of any better prices being realised. Forge and manufacturing coal does not seem to make much headway, although there is more doing in the iron trade. The demand for engine slack has improved in the cotton manufacturing districts. Shipments of coal are also better on the Manchester Ship Canal, and the prospect forward is good. Ordinary quotations are:—Best coal for domestic purposes, 13s. to 14s.; seconds, 12s. to 13s.; common, 9s. to 10s.; steam and forge coal, best, 8s. 3d. to 8s. 9d.; best engine slack, 7s. 6d. to 8s.; medium, 6s. to 6s. 9d.; common, 4s. 3d. to 5s. at the pit. Unscreened ex Manchester Ship Canal, 8s. 9d. to 9s. 2d.; screened ditto, 9s. 3d. to 9s. 9d.

Barrow.—There is a distinct improvement to note in the hematite pig iron trade this week. A better demand has sprung up for mixed Bessemer numbers on the part of steel makers and others, and the pleasing necessity has been forced on makers to increase their output of iron by putting additional furnaces in blast. Arrangements are at the moment in progress for blowing in three extra furnaces. This will increase the number in blast to 27. It is expected one or two furnaces will go in at the Barrow works. For some time past only four furnaces have been producing iron, but that because of the very small supplies of crude iron required at the adjoining steel works. The consumption of iron in the latter is now on the increase. Makers' stocks have now almost vanished, and warrant stocks stand as last week at the low point of 12,392 tons. Prices are steady at 56s. for makers' iron net f.o.b., with warrant iron at 56s. 1d. net cash sellers; no buyers. Very little business is being done in forge and foundry iron, but charcoal iron enjoys a good market, and makers are fairly well sold forward.

Iron ore is in much better demand, although local raisers find an increasing tonnage of Spanish ore coming to hand in competition with native sorts. The latter are selling at 8s. 9d. per ton net at mines for good average qualities.

The steel trade is much more actively employed. Not only are the rail mills still working on full time, but business in plates has improved, and the mills are to be put on full time. How long this new activity will last remains to be seen, but there is a probability of a general strengthening of the market all round, and it is expected after the turn of the year more business will be done in both Bessemer and open-hearth steel.

More activity is expected in shipbuilding and engineering yards, but at present the number of men employed is much below the average. There are indications of some orders for foreign navies, as well as orders from the British Admiralty, while a few orders are in the market for the mercantile marine. Gun mountings are in very good demand.

The promoters of the East and West Coast Railway are not promoting a Bill in Parliament for next session, but hope to do so in the session of 1906, as they have been liberally encouraged with offers of help in promotion money and in the capital required for the work. It is whispered that the North-Eastern Railway Company, seeing the popularity of the scheme, will introduce an alternative one by the construction of a railway from Hawes Junction, on their present system, to Hurcaster, on the Furness Railway.

Shipping remains quiet. The exports last week were 7557 tons of iron, and 4887 tons of steel; total 12,444 tons, in contrast with 13,744 tons in the corresponding week of last year, a decrease of 1300 tons. Total shipments for the year 676,361 tons; corresponding period of last year, 813,962 tons, decrease 137 601 tons.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

ALTHOUGH the weather continues exceptionally mild, the demand for house coal is well maintained, more particularly in regard to the thick seam pits, which are kept practically at full time. A heavy weight is being brought to the surface, but a market appears to be found for it. The thinner seams are not so well employed, and in some instances considerable complaint is heard. On the whole, however, all things considered, the trade in household fuel is not unsatisfactory. The metropolitan, southern, and eastern markets are sending fair orders, but there is a little weakness in the local demand. For Silkstones, which are not in large supply, prices are a little better, the best sorts fetching from 12s. to 12s. 6d.; secondary qualities, 11s. to 11s. 6d. per ton. Barnsley thick seam coal, in which the largest trade is done, may be quoted at 10s. 3d. to 10s. 6d. in the best qualities, other grades being obtainable at from 8s. 9d. to 9s. 3d. per ton at the pits in owners' wagons.

In steam coal, although little is being done on shipping account, owing to the season of the year, the trade is quite equal to what is usual at this time. There is some movement with regard to railway contracts. At one time these were made for the full twelve months, but they now vary considerably, several companies being content to arrange for supplies for the half-year, and others preferring to go from quarter to quarter. Tenders have not yet been asked for, but there is a general opinion that the rate of new contracts will be somewhat similar to last year, if not a little better. The best hard coal at present fetches from about 8s. 3d. to 8s. 6d. per ton, secondary qualities being easier. In gas coal heavy deliveries are being made under contract to gas companies and Corporation gas departments. The price of coal bought in the open market rules a little higher.

In slack the better qualities find a ready market, and there is even a slight betterment reported in the commoner kinds of slack and smudge used for engine purposes. The greater activity in the Lancashire textile trade has had a good effect on this class of fuel, and more is going to the various Yorkshire woollen districts, where business is again better. In coke there is little improvement to report. The make, although small, is equal to all requirements, and is principally confined to coalowners who have their own ovens. There is rather more doing with North Lincolnshire, where there is certain to be an improvement in value if the report that additional furnaces are to be blown in should turn out to be correct.

A distinctly hopeful feeling is at present perceptible in local business circles, although up to the present it has not been followed by any specific placing of fresh work. The iron market is decidedly firmer, and prices show an advance upon those previously reported. Contracts are now being placed, instead of consumers simply ordering for immediate requirements. To-day the quotations are as follows:—West Coast hematites, 64s. per ton; East Coast hematites, 59s. per ton; Lincolnshire foundry, 47s. per ton; Lincolnshire forge, 44s 6d. per ton; bar iron, £6 5s. to £6 10s.; Bessemer billets, £6 10s.; Siemens billets, £7 5s. Generally, quotations all round are firmer, and there is every expectation that the advance obtained in Lincolnshire iron will be followed by a further upward tendency.

The reports as to the Brazilian Government being likely to place orders for armour plates and other material connected with a new shipbuilding programme have not been followed by any actual work as yet. This question has been before the Brazilian Government for some time, but no definite decision appears to have been yet arrived at. In any case there is no information at Sheffield of such work having been placed or likely to be placed in the immediate future. No further orders from the British Admiralty are expected this year. Those in hand are now fairly well on their way towards completion. In tramway material there is still considerable activity.

Messrs. John Brown and Co., Limited, Atlas Works, are finishing for the battleship Africa two propeller shafts which are believed to be the largest forgings of the kind ever produced. They measure over 80ft. in length, are 20in. in diameter, and are bored to a diameter of 12in. The weight of each shaft is 27 tons. Orders for some very heavy shafting have also been recently placed with Messrs. Vickers, Sons, and Maxim, Limited, River Don Works.

In railway material manufacturers complain of the lightness of such orders as are being received, but there is rather more doing in wheels and wagons, although the competition is stated to be so keen as to keep prices unusually low. The orders which have recently been placed have been chiefly on foreign and colonial account, the demand for home companies having been very disappointing.

The foreign trade in cutlery for November reached a value of £58,042, against £53,991 and £62,320 for the corresponding months of 1903 and 1902. For the eleven months the value was £631,683, against £623,629 and £599,356 for the similar periods of 1903 and 1902. It is distinctly disappointing to note that British South Africa shows such weak results, the values for the eleven months of the three years coming out thus:—1902, £117,385; 1903, £108,608; 1904, £55,674.

In the lighter trades of the city the season orders in view of Christmas and the New Year are now being completed. They have been, on the whole, more satisfactory than at one time appeared probable, but they will be found insufficient to give anything like full employment in all the works up to holiday time. Although the outlook for the New Year is fairly promising with several of the larger establishments, in the case of others it is not so hopeful. In the heavier trades it is the intention of several firms to give a full week's holiday, and in not a few of the lighter departments there will be a fortnight's play. Manufacturers of edge tools are still waiting for that activity which was anticipated before the end of the year, but there is every prospect that 1905 will find these departments, both in heavy and light tools, much better off than they have been during the present year. The principal demand at present is in mining and excavating implements, as well as in spades, picks, and shovels.

Mr. Harry Cooper, of Sheffield, for many years with Messrs. Vickers, Sons and Maxim, Limited, has joined the directorate of Hadfield's Steel Foundry Company, Limited.

On the 2nd inst., Mr. J. H. Biles, Professor of Naval Architecture at the Glasgow University, and vice-president of the Institute of Naval Architects, lectured on "Ships" at the technical department of the University College, St. George's-square, Sheffield. The lecture was under the auspices of the Sheffield Society of Engineers and Metallurgists. The president, Mr. J. H. Ellis, of Messrs. John Brown and Co., Limited, occupied the chair. The lecture, which was of a most interesting character, dealt with ships of all types from the earliest periods. Comparing the modern Triumph and the Swiftsure with battleships of the Revenge class, Professor Biles said that both those vessels could do as much damage as five of the latter class. Speaking generally, the attacking power of the guns had doubled in ten years. The conflict between gun and armour went on apace, but though marvellous progress had been made with armour, the gun has so far got the better of the fight. Speaking of propelling power, he said it was necessary to have a propulsive instrument that would give the highest speed. The steam turbine was at present that instrument, and its general adoption was not far distant. Afterwards the lecturer dealt with the technical side of naval construction. At the close Professor Biles was accorded a very hearty vote of thanks.

NORTH OF ENGLAND.

(From our own Correspondent.)

THE progress of the "gamble" in Cleveland warrants continues to take up general attention in commercial circles in this district, greatly to the detriment of legitimate business in Cleveland pig iron, for the regular market is rendered too uncertain, and no consumer buys where he can put off. The fluctuations in warrant prices have been somewhat violent, more so than they have been since the "gamble" commenced. On Monday buyers were offering 48s. 9d. per ton cash for warrants, that being the highest figure reached not only this year, but since April, 1903, and it was 7s 1d. per ton above the minimum of this year, and showed 6s. 6d. rise since the present movement in warrants began. But on Wednesday speculators were selling in order to secure profits, and that caused the price of warrants to fall sharply; in fact, there was close upon 1s. fall from Monday's top price, seeing that at the close only 47s. 9½d. cash would be given, and there were sellers at 47s. 10d. Experienced traders are not alarmed at this fall, because it is only what might be expected. In every upward movement in warrants the prices never rise without a break, there are invariably "slumps" at intervals, due to speculators realising in order to secure profits, and more particularly is this so when the general public come in to have a "flutter," as they have been doing for the last two or three weeks.

It is not believed that the easier prices that have ruled since Tuesday in Cleveland warrants afford any indication of the "beginning of the end" of the gamble; on the contrary, it is expected that operations will be carried on for some time yet, and some traders would not be at all surprised to see them continued until the spring trade opens, in which case the improved regular trade would prevent any material falling back in prices. A good many of the recent transactions in Cleveland warrants, it is to be noted, do not mature till February.

Consumers of Cleveland pig iron this week have bought more freely than for some time, but purchasers are mostly those who are obliged to procure pig iron to keep their establishments going, and no one will buy Cleveland iron for delivery more than a few weeks ahead. No. 3 Cleveland G.M.B. pig iron has realised up to 48s. per ton, that being 5s. 6d. more than the figure reported when the upward movement started in July. On Wednesday the drop in warrants led to some of the second hands selling at 47s. 3d., but makers were in no hurry to pull down their prices. Quotations for the other qualities of Cleveland pig iron were maintained, but they are relatively a good deal cheaper than No. 3, and are not so much influenced by the fluctuations in warrants, for they are not to be found in the public warrant stores. No. 4 foundry is at 46s. 3d., No. 4 forge at 45s., mottled at 44s., and white at 43s., these figures being about 1s. per ton above those reported last week.

A steady improvement is going on in the hematite pig iron trade, which, no doubt, is the result of a *bonâ fide* demand from the actual consumers. Speculation has little to do with it, because, as a matter of fact, there is not much opportunity afforded for that, seeing that only 300 tons of hematite are held in the public warrant stores. Traders look upon this improvement in hematite iron with much satisfaction, as there is a sound foundation for it. The large consumers are becoming keen buyers, not only for prompt, but also for forward delivery. Makers have this week had to furnish quotations for delivery over the whole of 1905, and American firms have inquired for quotations for considerable quantities of special hematite iron, delivery to be in the early part of next year. An order for several thousand tons of spiegel iron has been secured by Middlesbrough ironmasters for early shipment to the United States; indeed, 4000 tons will be sent away within the next few days from the Tees in the steamer Tampico. The price of mixed numbers of East Coast hematite pig iron has been raised to 54s. per ton for early delivery, that showing a rise of 4s. 6d. per ton since prices took an upward turn, of which 1s. 6d. has been obtained since the beginning of last week. Hematite pig iron makers this year have had a very hard time, but are now reporting cheerfully about their position and prospects. There is certainly more ground for the advance in hematite than there is for the larger rise in Cleveland iron. Rubio ore has been raised in price, the Spanish mine owners being very keen to take advantage of the advances in pig iron rates. Some of the merchants have put up their quotations to 15s. per ton, c.i.f. Tees, but there are sellers at 14s. 10½d., or 3d. advance on last week.

The November shipments of pig iron from the Cleveland district afford some indication of the extent of the depression existing in the trade, for the 68,607 tons exported were the worst that have been reported in any month since January, 1902, and not since 1892 has there been so bad a November. The average export in November for the last ten years has been 94,000 tons, and last month's were therefore 27 per cent. below that, while they were 20 per cent. below the monthly average for this year. To Scotland only 25,188 tons were shipped, the smallest tonnage reported in any

month for several years, and it is 30 per cent. below this year's monthly average. During the eleven months of this year Cleveland has exported only 939,299 tons of pig iron, the smallest quantity since 1894. To foreign countries the export was 448,117 tons, the poorest for ten years, and it compares with 795,375 tons in 1899, the latter being the record.

Last month the stock of Cleveland pig iron in Connal's public stores increased no less than 34,572 tons, making 54,711 tons increase in two months, and the quantity now held is just double that reported in July, 78,019 tons, for on 6th inst. the quantity was 156,682 tons, over 1400 tons per working day being added.

The manufactured iron and steel industries show some improvement. Partly on account of this, but more because of the rise in hematite pig iron, advances in prices, both of finished iron and steel, may be looked for within the next week or two, especially as quotations have been raised in Scotland. The rates for bars have not been altered at any time this year, and steel ship plates have remained unchanged since February, but it is now becoming necessary to secure better prices to cover the increased cost. This week steel ship plates are at £5 12s. 6d.; iron ship plates, £6; steel boiler plates, £6 17s. 6d.; steel ship angles, £5 5s.; iron ship angles, £6 2s. 6d.; steel bars, £6; and iron bars, £6 2s. 6d., all less 2½ per cent. Steel rails, heavy, are quoted at £4 10s., and cast iron chairs at £3 7s. 6d., both net.

The settlement of the wages difficulty in the shipbuilding industry of the North-East Coast has given considerable satisfaction, but it has not been followed by any increase in the number of orders for new vessels, as many expected it would be. The less favourable condition of the freight market and the increased prices which shipbuilders have felt compelled to quote fully account for this. The freight market is worse than ever, and no one will deny that the outlook is bad for the shipowners. A good many of the orders they have given out lately have been placed because owners were tempted by the very low prices that the shipbuilders quoted, prices which certainly could not leave them with profits. There is no longer this temptation, for builders, who have within the last few weeks taken orders at £5 5s. per ton for ordinary cargo steamers, now quote £5 10s., and even £5 15s. It is true that the builders will reduce wages early in January, according to the arrangement made last week, but the prices of materials are going up. Angles have increased in value 7s. 6d. per ton, and within the next few days the quotations for plates will almost certainly be raised, as they have been in Scotland. Shipowners are thus inclined to hang back, and the prospects will have to be a good deal better than they are before any real improvement in shipbuilding can take place. Messrs. Robert Stephenson and Co., Limited, have appointed Mr. George A. Skentlebury as their dry docking representative on Tyneside. Mr. Skentlebury has represented the Wallsend Slipway and Engineering Company, Limited, and also Messrs. Swan, Hunter and Wigham Richardson, Limited.

The engineering industry is somewhat better, and has not suffered from the depression so keenly as some of the other industries of the district. Messrs. Robert Stephenson and Co., Limited, have received at their Darlington Works an order for ten large passenger engines and tenders for the Shanghai-Nanking Railway, the engine having four wheels coupled and a leading four-wheeled bogie, and the tenders being six-wheeled. The North-Eastern Railway Company has adopted a practice, which is general on the leading American railways, of centralising in one special department the whole of the work connected with the consideration of all questions of claims arising from both goods and passenger traffic. They have appointed Mr. E. C. Giddes as chief claims agent, with headquarters at York. Mr. Giddes has for some years held an executive position on the Indian railways. Since the 1st inst. the North-Eastern Railway Company has abolished the ordinary steam train service on their Port Clarence and Billingham branch, except on the Saturdays, and has substituted the two petrol-driven vehicles which in the summer ran between Scarborough and Filey. They will each hold fifty-two passengers, and there is only one class. Once a day a car runs through to Hartlepool. If the arrangement is found to answer the cars will remain permanently on the section.

The coal trade is quiet, but prices are fairly well maintained, and contracts which are made for next year's execution are on a basis fully up to that of contracts now running; in fact, for coke for next half-year's delivery better prices are realised than those obtained for the current half-year. Thus medium coke for prompt is 14s. 6d. per ton, delivered at the Middlesbrough furnaces, and 14s. 9d. for the first quarter of next year, but 15s., and even 15s. 3s., have likewise been paid, and the tendency is upward. Best steam coals are firm at 9s. per ton f.o.b., and best gas coals cannot well be had under 8s. 1½d. Mr. Seymour Wood, son of Mr. W. O. Wood, agent for the South Hetton Coal Company, has been appointed manager of the Dawdon Colliery. Mr. Wood was formerly manager at South Hetton, and latterly has had charge of a large colliery in India.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has this week been considerable activity in the pig iron warrant market. Prices have fluctuated to some extent, but the general tendency still appears to be upward. The turnover of Cleveland warrants seems to indicate that a large speculative business is being done. At the same time, the advances in prices that have been taking place in other districts at home and abroad are imparting strength to the position of the market.

Business has been done in Cleveland warrants from 48s. 10d. to 48s. 6d. cash, 49s. 8½d. fourteen days, 48s. 8d. twenty-days, and 48s. 8½d. to 48s. 10½d. one month. Scotch warrants are quoted 53s. 3d., and Cumberland hematite 55s. 9d. per ton.

There is a steady demand for Scotch hematite pig iron, which is again higher in price, merchants quoting 58s. 6d. for delivery at the West of Scotland steel works.

The prices of Scotch makers' iron are in some cases higher, the advance ranging from 6d. to 1s. 6d. per ton. G.M.B. f.o.b., at Glasgow: No. 1 is quoted 53s. 6d.; No. 3, 50s. 6d.; Carnbroe, No. 1, 54s. 6d.; No. 3, 51s. 6d.; Clyde, No. 1, 57s. 6d.; No. 3, 53s.; Gartsherrie, No. 1, 58s.; No. 3, 53s. 6d.; Summerlee, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Langloan, No. 1, 64s.; No. 3, 54s.; Coltness, No. 1, 64s. 6d.; No. 3, 50s. 6d.; Glengarnock, at Ardrossan, No. 1, 58s.; No. 3, 52s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 53s. 6d.; No. 3, 51s.; Dalmellington, at Ayr, No. 1, 53s.; No. 3, 50s.; Shotts, at Leith, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Carron, at Grangemouth, No. 1, 58s. 6d.; No. 3, 53s. per ton.

The stock of pig iron in the Glasgow warrant stores shows an increase for the past week of 512 tons, bringing up the total to 10,070 tons.

There are 41 furnaces making ordinary, 38 hematite, and 6 basic iron, the total of 85 furnaces thus blowing in Scotland comparing with 86 at this time last year.

The shipment of pig iron from Scottish ports in the past week amounted to 3302 tons, against 4360 in the corresponding week of last year. There was despatched to Canada 90 tons, South America 100, India 5, Australia 112, Italy 210, Germany 95, Holland 305, Belgium 10, Spain and Portugal 5, China and Japan 10, other countries 35, the coastwise shipment being 2335 tons, compared with 2130 in the corresponding week of last year.

The arrivals of Middlesbrough pigs at Grangemouth amounted to 9978 tons, compared with 9133 in the corresponding week, showing an increase of 845 tons. The total decrease in these imports since the beginning of the year amounts to 94,214 tons.

The rapid increase in the cost of raw iron has made it imperative that manufacturers of finished iron and steel should increase their prices. In the course of the past week advances have been made in various kinds of manufactured iron, varying from 2s. 6d. to 5s. per ton. The upward movement of the market has been calling out some additional orders, but trade is by no means so active as could be desired. In some cases the steel makers are reported to be looking anxiously for additional specifications in order that they may keep their works fully going.

A few fresh shipbuilding orders are reported on the Clyde in the last few days, but there is still a good deal of room for work of this description in some of the yards.

The volume of business in the shipping department of the coal trade has been extending. The coal shipments from Scottish ports in the past week reached 256,117 tons, compared with 219,205 in the preceding week, and 200,408 in the corresponding week of last year. Main coal is quoted f.o.b. at Glasgow 7s. to 7s. 6d.; ell, 8s. 3d. to 8s. 9d.; steam, 8s. 6d. to 8s. 9d.; and splint, 8s. 6d to 9s. per ton.

The demand for shipments has been increasing. Household coal has sold freely for home use, and manufacturing qualities are also going off steadily. Prices are generally 6d. to 1s. better than they were several weeks ago.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE German "collier," the Capt. W. Menzell, which returned to Cardiff last week after taking out a cargo of coal—stated to have been placed on board a Russian vessel—has now been prevented by Government orders from re-loading. Customs officials, too, I hear, are on the alert in pressing for fuller information, in all suspicious cases, of the actual destination of a cargo; but, as coalowners say, they do not think this will interfere with the trade to any marked extent. One of the vessels under observation at present is the Bengali, loading at Barry. This will take out 9000 to 10,000 tons. Both Russia and Japan are placing large orders, and it is currently stated on 'Change that Russia had previously secured 600,000 tons, which have been sent to Vladivostock, and safe Chinese ports. Attention has been directed towards the Ingrad Horn, a German vessel, which was chartered by the Russians, and is stated in Cardiff to have accompanied the Baltic Fleet through the Suez Canal. It left Cardiff on September 29th for the Canary Islands with 3000 tons of coal. It has now arrived at Genoa.

It is expected that the steamer, the Captain W. Menzell, will be ordered to proceed in ballast to Hamburg. In the case of the Bengali, now loading, strict inquiries are being made as to whether this vessel did coal the Russian fleet. Up to my despatch no orders have been received to prevent her sailing. The weather has told adversely against coal shipments, and this week few were cleared; amongst them, however, were the Heathburn for Shanghai with 6400 tons, the Ras Dara for Batoura with 5000; the Canaxa for Teneriffe with 4200 tons.

Mid-week, on 'Change, Cardiff, it was stated that there was no alteration in price or any marked improvement in trade. The severe weather of late has told on the shipping business at all ports, rendering the work of navigating the Bristol Channel one of difficulty; not only high seas and gales, but the prevalence of fogs, one of the greatest, if not the greatest, enemy the coal steamers have to contend with.

Newport figured well last week in coal shipments, for which Swansea only despatched about 41,000 tons; the Uskside port cleared over 80,000 tons, of which 61,227 were for foreign, and the other coastwise directions.

Monmouthshire semi-bituminous coal is in better demand, and, judging from the enterprise now being shown in the Monmouthshire Valley, prospects are good.

Closing prices this week at Cardiff were as follows:—Best steam, 13s. 3d. to 13s. 6d.; best seconds, 12s. 9d to 13s.; seconds, 11s. 6d. to 12s.; drys, 11s. 9d. to 12s. 3d.; best smalls, 7s. to 7s. 3d.; best ordinaries, 6s. 3d. to 6s. 6d.; seconds, 5s. 9d. to 6s.; inferior, including drys, from 5s. 6d. Monmouthshire semi-bituminous:—Best large, 11s. 6d. to 11s. 9d.; best ordinaries, 11s. 3d. to 11s. 6d.; seconds, 10s. 6d. to 10s. 9d.; best house coal, 16s. 6d. to 17s., demands steadily increasing, but without much change in price; best ordinaries, 13s. 6d. to 14s. 6d.; seconds and other sorts, 10s. 6d. to 13s. No. 3 Rhondda, 13s. 3d. to 13s. 6d.; brush, 11s. 6d. to 11s. 9d.; small, 9s. 6d. No. 2 Rhondda, 9s. 9d to 10s.; through, 8s. 3d. to 8s. 6d.; small, 6s. 6d. to 6s. 9d. Patent fuel, 12s. 6d. to 13s. Coke, 15s. to 20s., according to brand.

The slackness at port is reacting on collieries, and idle days are common. At Garth-Merthyr there is a deadlock, which has lasted several months. A resumption is expected after Christmas; 300 men are concerned. A large mineral taking in the Garw Valley is announced, and a strong company has been formed.

Little improvement is showing in the Swansea coal trade. Steam coal slack, prices down to 12s. 6d. to 13s.; house, 13s. 6d. to 13s. 9d. For anthracite there is only moderate requirement; latest prices are:—Best malting from 20s.; seconds, 17s.; big vein, 12s. to 12s. 3d.; red vein, 10s.; cobbles, 17s. to 17s. 6d.; nuts, 18s. to 20s.; peas, 11s. to 12s.; rubbly culm, still low, 4s. 6d.; duff, 4s. Patent fuel quiet; despatch last week was under 9000 tons. Quotations, 11s. 6d. to 11s. 9d., including tax. In the Swansea district many of the collieries are only working half time. Latest report from Exchange was that in house coal demand and price were being maintained; heavy loading for San Francisco likely. Pitwood generally brisk. Quotations, Cardiff, from 17s. 6d. to 17s. 9d. Last week's imports to Cardiff were strong.

Monmouthshire and South Wales appear to have a fair share of rail orders. I note amongst recent cargoes despatched, some for Cochin, Madras, and Calcutta, another for Bombay and Kurachee, one to Kurachee of 4800 tons, and last week the Dowlais works were employed on rails for the London and South-Western Railway and for South America. These represent large orders. One for China is also in hand, and a quantity of fish-plates. Amongst the home requirements the Great Western figures, and colliery rails continue in moderate demand.

In the matter of imports, one cargo of steel has come to hand at Newport from Antwerp, one to Swansea from Philadelphia, and various cargoes of ore from Bilbao and ore from Pomaron. The importers of ore were principally Blaenavon, Ebbw Vale, and Dowlais. Cyfarthfa has been fairly busy with tin bar.

In the Swansea district there is active business going on in raw ores, and large consignments coming in for spelter and sulphuric acid requirements. Average output of pig recorded, but a large production of steel bar for local use. Another furnace is being built for Cwmfelin. This will give 40 tons per charge, or double the capacity of the old furnaces.

There is no abatement in the activity in the tin-plate trade, and all the mills are in full work. One welcome feature, too, has been the improvement in the finishing processes and the necessary employment of workers who have suffered from the American tariff. Last week the shipment of plate was 80,473 boxes; make, 89,766 boxes; present stock, 143,683 boxes. A large number of vessels are on the eve of loading. Prices firm and quotations given strongly held:—Bessemer steel coke, 12s. 7½d. to 12s. 9d.; Siemens coke finish, 12s. 10½d. to 13s.; ternes, per double box, 28 by 20, 23s. to 25s.; best charcoal, 14s. 3d. to 14s. 6d.; big sheets for galvanising, 6ft. by 3ft. by 30ft., per ton, f.o.t., £9 to £9 2s. 6d.; finished black plate, £8 17s. 6d. to £9. Block tin is at £133 17s. 6d.; slab tin coming in from Penang; lead, £13 2s. 6d.; spelter, £25; copper, £66 10s. 3d. In the matter of pig iron there has been another advance of price in Middlesbrough to the extent of 1s. 3d. Glasgow warrants remain, but hematites are 3d. better.

Latest prices:—Glasgow pig iron warrants, 53s. 3d.; Middlesbrough No. 3, 48s. 6d.; hematite, 55s. 9d.; Welsh bars, £6 2s. 6d. to £6 5s.; sheet iron, £8 5s. to £8 10s.; steel sheets, £8 2s. 6d. to £8 5s.; Bessemer steel tin-plate bars, £4 5s.; Siemens tin-plate bars, best, £4 7s. 6d.; iron ore, 13s. 6d. to 14s. 3d.

At Dowlais the Siemens furnaces are being vigorously worked, but the old Bessemer and the tin-bar mill remain idle.

Good average work is being done at the Llanelly works. At Briton Ferry 21 mills were active last week at the various works, and a gratifying state of trade was reported; output of hematite iron at Briton Ferry works large, and smelting furnaces there and at the Albion brisk.

Some little difficulty has arisen at Barry in connection with the trimmers, but judicious action by the management is being exercised, and the threatened strike may be expected to pass off.

NOTES FROM GERMANY.

(From our own Correspondent.)

FROM Rheinland-Westphalia and the adjoining districts the same reports are given as before with regard to demand and employment in the iron and steel industry. Trade keeps quiet in the pig iron department, and prices remain the same as formerly; in some branches of the manufactured iron business a little more life has been stirring than in the beginning of the present quarter, but here, too, no improvement in quotations can be reported, except for bars and flat iron, to which reference was made in last week's letter.

For some time past endeavours have been made to unite the finishing trades, *i.e.*, the rolling mills, hardware factories, and the machine shops, and a meeting that will soon take place in Cologne is expected to lead to a satisfactory result in this matter, the more so, because, according to the *Rheinisch Westphalische Zeitung*, two of the leading manufacturers in the machine department take an interest in the matter.

Silesian ironmasters have been doing a pretty lively business during the week. Forward orders on foreign account have been increasing, and the home trade was also fairly active. The tendency all round is quiet but steady, and demand continues regular in most branches. Prices, if not inclined to rise, have at least been exhibiting much firmness. The rolling mills are reported to be specially well occupied. Heavy plates and sheets show a fair briskness. In the pipe trade the competition of the "outstanding" mills in the West of Germany is complained of.

Concerning the import of iron plates to Constantinople, it has been officially stated that in 1903 about 3000 t. were imported, 2500 t., worth 450,000f., coming from Belgium, and 500 t., worth 100,000f., being sent from Germany. Not until after the forming of the Sheet Convention, however, has Germany been seriously endeavouring to do business in thin plates with Turkey. Formerly only a small and irregular trade was done, and even now the business in sheets is getting on but slowly, as German sheets are rather too dear. A horseshoe factory in Constantinople has of late been consuming chiefly Siemens-Martin plates from Germany.

Good accounts are given regarding the coal industry in Rheinland-Westphalia, inquiry and demand for engine and house coal improving slowly from week to week. The frosts that set in a fortnight ago have tended to improve the tone of the house coal trade, and though this week the weather has become warmer again, the demand for house coal continues fairly strong. Still, when compared to what is usually bought at this time of the year, the sales in house coal, during this week and the last, have been rather limited. All classes of engine coal are in fairly good call, and coke as well as briquettes sell briskly; the latter especially are in rising demand. Pretty much the same is reported from the Silesian coal market, last week's trade having been pretty good generally.

Official accounts concerning German general foreign trade during the period from January 1st to end of October of present year have just been published. They show imports to have been 39,841,146 t., against 38,852,859 t. and 36,185,636 t. in the same period in the two years before, increase thus being 988,287 t. and 3,655,510 t. Import in noble metals was 1122 t., against 1041 t. and 997 t. Export was 31,803,989 t., against 31,648,003 t. and 28,602,602 t. in the two preceding years, increase thus being 155,986 t. and 3,201,387 t. Export in noble metals was 304 t., against 299 t., and 349 t.

Business in iron and steel in Austria-Hungary continues fairly satisfactory, though no sales of importance could be effected, but a steady sort of trade was done in most branches, and quotations have been, on the whole, well maintained.

Coal and coke are in active request in Austria-Hungary, and the brown coal trade improves perceptibly.

The French iron market is much as last reported, the crude and finished iron trades maintaining the satisfactory character shown before. Activity has here and there been increasing. Coal and coke are in regular request in France, and quotations exhibit firmness in most districts. There is nothing of special importance to relate with regard to the Belgian iron industry, the various branches being in good employment, and prices stiff as a rule. Also coal, both for engine and house-fire purposes, sells well, and coke is in steady request.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market easier, there still being a want of ready tonnage. House coal in fair demand, both for shipment and inland trade. The quantity of coal shipped for week ending 3rd was 82,553 tons—foreign, 61,227 tons; coastwise, 21,326 tons. Imports for week ending 6th:—Iron ore, 17,365 tons; pig iron, 2804 tons; scrap, 22 tons; deals, 486 loads; pitwood, 8382 loads.

Coal—Best steam, 11s. 6d. to 11s. 9d.; seconds, 10s. 6d. to 10s. 9d.; house coal, best, 15s.; dock screenings, 6s. 3d.; colliery small, 5s. 9d. to 6s.; smiths' coal, 9s. Pig iron—Middlesbrough No. 3, 48s. 1½d. to 48s. 2d.; Middlesbrough hematite, 56s. 3d. Iron ore—Rubio, 14s. to 14s. 6d.; Tafna, 15s. 6d. Steel—Rails, heavy sections, £4 10s. to £4 12s. 6d.; light ditto, £5 10s. to £5 12s. 6d.; Bessemer steel tin-plate bars, £4 2s. 6d. to £4 5s.; Siemens steel tin-plate bars, £4 5s. to £4 7s. 6d., all delivered in the district, cash. Tin-plates—Bessemer steel, coke, 12s. 7½d. to 12s. 9d.; Siemens, coke finish, 12s. 9d. to 13s. Pitwood—18s., ex ship. London Exchange telegrams—Copper, £66 to £66 10s.; Straits tin, £133 15s. to £133 17s. 6d.

Freights active, rates steady.

TRADE AND BUSINESS ANNOUNCEMENTS.

THE NEW EXPLOSIVES COMPANY, Limited, has removed its office to 62, London Wall.

THE registered office of the Newcastle-upon-Tyne Electric Supply Company, Limited, has been removed from 50, New Bridge-street, to Royal Exchange-buildings.

WE hear that the action brought by Messrs. D. and I. Tullis, Limited, to restrain Messrs. W. Summerscales and Sons, Limited, of Keighley, from making and supplying a "Foul Linen Washing Machine," has been withdrawn by the plaintiffs.

MR. ALFRED H. GIBBINGS asks us to state that, owing to the completion of his engagement with the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board, on December 31st next, his address will be "Lynton," Wellington-road North, Stockport.

MESSRS. HORACE P. MARSHALL AND CO., late of 37, Basinghall-street, Leeds, inform us that they have now removed to larger and more convenient premises at 6 and 7, Cross Fountaine-street, Leeds.

THE railway accidents in the United States in October included 25 collisions, 16 derailments, and three other accidents.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

22nd November, 1904.

25,370. TELEPHONY, J. H. Lee and A. E. R. Bottone, London.
25,371. VARIABLE SPEED GEARING, C. J. Rawlinson, London.
25,372. LIQUID FUEL BURNERS, W. C. Fairweather.—(*Vereinigte Metallwaarenfabriken Akt.-Ges. vormals Haller and Co., Germany.*)
25,373. BOILER FURNACES, E. H. Wade and J. L. Nicholson, London.
25,374. VARIABLE SPEED GEARINGS, E. H. Belden, London.
25,375. STORE SERVICE APPARATUS, E. C. Gipe, London.
25,376. ELECTRIC BATTERIES, H. Csanyi, E. Klupathy, and G. von Bárczay, London.
25,377. ROTARY PUMPS and ENGINES, W. von Pittler, London.
25,378. ELECTRIC AIR-GAP CONDENSERS, H. H. Lake.—(*The Electro-Radiation Company, United States.*)
25,379. FOLDING POCKET CAMERA, J. S. Wright, London.
25,380. WOOD COLUMNS, J. W. Hartmann, London.
25,381. MOUNT COMBINED with ENVELOPE, H. C. Willmott and L. S. Tuckett, London.
25,382. ROTARY SPARK-GAP APPARATUS, H. H. Lake.—(*The Electro-Radiation Company, United States.*)
25,383. PHOTOGRAPHIC SHUTTERS, J. S. Wright, London.
25,384. IGNITION DEVICES, H. T. and H. A. Dawson, London.
25,385. MATERIAL for PAVING of ROADWAYS, J. Wilkinson, London.
25,386. SINGLE-PHASE COMMUTATION MOTORS, T. von Zweigbergk, London.
25,387. ROAD WHEELS for MOTOR VEHICLES, J. Rothhardt, London.
25,388. LIVE AXLE, F. Pilain, London.
25,389. PAVEMENTS for ROADS, F. J. Nash, London.
25,390. PAVEMENTS for ROADS, F. J. Nash, London.
25,391. FRICTION WINDOW BLIND, C. M. Roby, London.
25,392. LINOTYPE MACHINES, W. H. Lock and F. W. Sutcliffe, London.
25,393. LUMINOUS SIGNS, R. von Horváth, London.
25,394. OBTAINING a DISSOLUTION of SODIUM SILICATE, J. B. Watson, London.
25,395. TUBE MILLS for PULVERISING MINERALS, W. E. Bleloch, London.
25,396. OPERATING TRAMWAY POINTS, J. Levy, London.
25,397. BUTTON BOOTS, H. C. Jenny, London.
25,398. EXPLOSIVE COMPOSITIONS, The New Explosive Company, Limited, and J. C. Ody, London.
25,399. ATTACHMENT for TYPE-WRITING MACHINES, C. Levick, London.
25,400. CASES for FISHING BAITS, C. and O. Wyers, Birmingham.
25,401. MECHANISM for PLOUGHING LAND, A. Chandler, Birmingham.
25,402. RECORD DISC for GRAMOPHONES, J. Berliner, London.
25,403. SPRING FORKS for CYCLES, P. E. Surleau, London.
25,404. PRODUCING GAS from PULVERISABLE FUEL, G. Marconnet, London.
25,405. PACKING RINGS for FLUID-PRESSURE TURBINES, A. W. Clarke, London.
25,406. AMPLIFYING VARIATIONS of ENERGY in ELECTRIC CIRCUITS, F. C. Hewitt, London.
25,407. PAN and ROLLER MILLS, The Renfrew Crusher Company, Limited, and E. D. Chester, London.
25,408. RESILIENT PAD for STAIR-TREADS, G. Maddox, London.
25,409. PNEUMATIC RIVETING APPARATUS, H. S. Potter and The Consolidated Pneumatic Tool Company, Limited, London.
25,410. TREATMENT of PATIENTS SUFFERING from BACILLAR DISEASES, G Stevenson, London.
25,411. PACKING and SHIPPING CASES, H. A. Penrose, London.
25,412. MACHINE for CLEANING STEAM BOILERS, H. Möller and V. O. Nordström, London.
25,413. CLUTCH, A. Vivinus, London.
25,414. CRUCIBLES for MANUFACTURE of GLASS, F. Lang, London.
25,415. APPARATUS for CATCHING FISH, O. G. Bolitho, London.
25,416. FIRING of CHARGES in INTERNAL COMBUSTION ENGINES, A. G. Nesfield, London.
25,417. MACHINES for TURNING HAY, W. E. Martin, London.
25,418. SASH FASTENER for WINDOWS, J. Harris, London.
25,419. SIZING SAND, R. C. Gardner.—(*E. Parker, Rhodesia.*)
25,420. GAS GOVERNORS, J. Stott, London.
25,421. UTILISING EXHAUST GASES, E. E. Glaskin, London.
25,422. FLOAT VALVES, J. Hussey, London.
25,423. BOOT and SHOE TREES, S French, London.
25,424. MANUFACTURE of CEMENTS from HOT FLUID SLAG, A. Ebers, London.
25,425. TEACHING WRITING, A. Jahn, London.
25,426. PUMPS, G. Schwenzer and T. Hammelrath, London.
25,427. STRICLES for CARD CLOTHING, H. L. Miller, London.
25,428. COLLAR BUTTONS, H. T. Murphy, London.
25,429. OBTAINING POWER from AIR, G. James and E. J. Richardson, London.
25,430. SHACKLE for COUPLING COLLIERY TRAMS, T. H Hadley and F. H. Smith, London.
25,431. TYPEWRITING MACHINES, J. T. Schaaff, Liverpool.
25,432. TYPEWRITING MACHINES, J. T. Schaaff, Liverpool.
25,433. CROCHETING APPARATUS, L. Egger, Liverpool.
25,434. FEEDING SHEETS of PAPER to MACHINES, F. E. Blaisdell, London.
25,435. SAW BENCHES, E. R. Gabbett, London.
25,436. FOLDING BRUSHES, B. M. Winkel and A. E. Simonsen, London.

23rd November, 1904.

25,437. STONEWARE PIPE JOINTS, R. Ewing, London.
25,438. MERRY-GO-ROUND, B. H. Bedell, M. Bird, and E. R. Harris, Lee, Kent.
25,439. WINDOW CASEMENTS, J. W. Moseley, Romiley, near Stockport.
25,440. TIME-RECORDING INSTRUMENTS, C. H. Guest, Draycott, Derbyshire.
25,441. VENTILATION of HOUSES, R. Bell, London.
25,442. SEWER BLOCK and PIPE RECEIVER, J. W. and L. Clark, Newport, E. Yorks.
25,443. TIP MACHINE for BOOTS, G. F. Long and A. J. Snow, Bristol.
25,444. FIRE-ALARM, W. Thomas, Ellesmere, Shropshire.
25,445. TREE GUARDS, J. H. Collett, Gloucester.
25,446. HORSESHOE PAD, T. H. Slack, Alderley Edge, Cheshire.
25,447. INTERNAL COMBUSTION ENGINES, J. D. Cross, Halifax.
25,448. JOISTING of STONEWARE PIPES, R. Ewing, London.
25,449. FORCING SHAFTS into WOOD ROLLERS, J. E. Milner, Huddersfield.
25,450. APPARATUS for CREATING an OPTICAL ILLUSION, T. Batty, Bradford.
25,451. SKIRT HOLDER for LADIES' DRESSES, T. Harrison, Birmingham.
25,452. LOOMS for WEAVING LENO, W. Smith and Bros., Limited, and E. Heyworth, Manchester.
25,453. TOBACCO PIPES, J. H. Smith Nottingham.
25,454. DEVICES for TRAWL NETS, W. J. Fleming and R. H. Gale, Hull.
25,455. INCANDESCENT GAS BURNERS, H. F. Pegden, Hull.
25,456. SUPPORT for WINDOW BLINDS, J. Short, Birmingham.
25,457. MANUFACTURE of BOLTS for DOORS, S. Wakelam, Birmingham.
25,458. ELECTRO-MAGNETIC CIRCUIT BREAKERS, Veritys, Limited, and A. E. Gott, Birmingham.
25,459. FASTENERS for BOOT LACES, F. E. Dunnett, Birmingham.
25,460. FASTENINGS of SHIPS, H. W. White, Southampton.
25,461. TWIST GEARING of ROVING FRAMES, A. Lees and Co., Limited, A. Hardman, and J. W. Clegg, Manchester.
25,462. CREELS USED in SPINNING MACHINES, A. Lees and Co., Limited, and L. Dunkerley, jun., Manchester.
25,463. BRUSH HOLDERS for DYNAMO-ELECTRIC MACHINES, E. S. W. Moore and S. Bourne, Wolverhampton.
25,464. AUTOMATIC FIRE-ALARM, E. K. E. Volrath, Manchester.
25,465. LAMPS for BURNING CARBURETTED AIR, A. Jaray, Manchester.
25,466. PNEUMATIC TIRES, D. France, Manchester.
25,467. WARPING MACHINES, J. H. Stott Manchester.
25,468. MULES and TWINERS, E. W. Pickering, Manchester.
25,469. SAFETY GEAR for MINERS' CAGES, W. D. Trick and G. Fadon, Bristol.
25,470. PROPELLING SHIPS, E. Buss, Glasgow.
25,471. METALLIC BEDSTEADS, W. Molineaux and A. H. Pratt, Birmingham.
25,472. CONSTRUCTION of ARTIFICIAL POSTS, N. M. e Iñarra, Liverpool.
25,473. UMBRELLA STANDS, J. Pearson. Liverpool.
25,474. MILKING MACHINES, H. D Fitzpatrick.—(*D. H. and E. J. Burrell, United States.*)
25,475. DEVICE for CLEANING WINDOWS, W. Bourne, Southport.
25,476. DEVICE for HANGING CURTAINS, W. Bourne, Southport.
25,477. PRESSURE-RAISING APPARATUS for AIR, W. S. Gillie, Edinburgh.
25,478. DETACHABLE SERVICE FUSE BOX, W. H. James, Maidenhead.
25,479. RUNNING GEAR for MOTOR VEHICLES, J. F. Murphy, London.
25,480. COMBINED SPEED INDICATOR and ODOMETER, H. Salsbury, London.
25,481. FOLDING BOXES, F. H. Ayres and H. Gale, London.
25,482. COOKING UTENSIL, A. and J. Hopkins, Birmingham.
25,483. PRINTING MACHINES, A. de O. P. Dias, Berlin, W., Germany.
25,484. RAILWAY SIGNALLING APPARATUS, P. Jacobi, Berlin, W., Germany.
25,485. PACKING CASES, D. Oppenheimer, Berlin, W., Germany.
25,486. BOTTLE STOPPERS, H. C. Radbruch, Berlin, W., Germany.
25,487. SAFETY OIL LAMP, T. E. T. and G. T. Jackson, London.
25,488. MATCHBOX, G. A. Layton, London.
25,489. METAL BLOCKS for PRINTING, J. Manham and G. Trapps, London.
25,490. CARBURETTER for INTERNAL COMBUSTION ENGINES, E. C. A. Griffith, London.
25,491. POLYGRAPHS, J. Westenhoff, London.
25,492. TROLLEY for ELECTRIC CARS, L. M. McBride, London.
25,493. FREE-WHEEL HUBS for CYCLES, S. Moore, London.
25,494. ADVERTISING by MEANS of LETTER CARDS, F. A. Unwin, London.
25,495. ROTARY ENGINES, J. H. Corthésy and G. F. Griffin, London.
25,496. PHOTOGRAPHIC CAMERAS, Houghtons, Limited, and W. Dockree, London.
25,497. BAKING VESSELS, R. F. Taylor, T. R. Law, and J. Malins, Birmingham.
25,498. GEAR WHEELS for ELECTRIC CARS, A. Wiseman, Birmingham.
25,499. COUPLING for COLLIERY TRAMS, W. David, London.
25,500. GEARING for WIND ENGINES, R. Andrade, London.
25,501. AUTOMATIC VACUUM BRAKES, G. J. Churchward, Swindon.
25,502. HEATING and COOLING APPARATUS, H. Junkers, London.
25,503. HIGH-SPEED STEAM ENGINES, R. H. Longbotham, London.
25,504. OSCILLATING MAGNETO SPARKING PLUG, R. H. Derry, London.
25,505. CHLORONITRANISOL, H. H. Lake.—(*K. Ochler, Germany.*)
25,506. SULPHUR DYES, H. H. Lake.—(*K. Ochler, Germany.*)
25,507. FURNACES, T. G. Blundell, London.
25,508. MOTOR CAR TIRES, J. J. Baghino and J. W. Hodgetts, London.
25,509. FRICTION COUPLINGS, A. J. Boult.—(*E. Oudenne, Belgium.*)
25,510. PLANIMETERS, P. Emanuelle, London.
25,511. SCREW-PROPELLED VESSELS, J. A., F. E., and M. E. Normand, London.
25,512. JOISTS for RAILS, C. H. Jerrard, London.
25,513. OUTDOOR SHOP LAMPS, W. T. Sugg, London.
25,514. PRESERVING PERISHABLE FOOD, J. Breckwoldt, London.
25,515. TYPEWRITERS, E. H. Brown and C. B. Jones, London.
25,516. TOBACCO PIPES, A. W. Montgomery-Moore, London.
25,517. SCREW PROPELLERS for SHIPS, G. Valdclièvre, London.
25,518. APPARATUS for CLEANING CURTAINS, A. Hein, London.
25,519. ELECTRIC INCANDESCENT CANDLE LAMPS, F. C. Dafforn, London,
25,520. APPARATUS for CIRCULATING AIR, F. de Mare, London.
25,521. SELF-CLOSING SEATS, T. S. James, London.
25,522. LAP MACHINES, W. R. Buckley and Taylor, Lang and Co., Limited, London.
25,523. LIGHTING LAMPS SIMULTANEOUSLY, J. W. Whimster, London.
25,524. ELECTRIC LIGHTING of RAILWAY CARRIAGES, O. Imray.—(*J. Denham, Capetown.*)
25,525. HAM WRAPPER, H. E. Matthews, London.
25,526. FEED MECHANISM of AUTOMATIC GUNS, A. T. Dawson and G. T. Buckham, London.
25,527. COKE FURNACES, H. Koppers, London.
25,528. WALLS, A. Mohr, Liverpool.
25,529. LAVATORY BATHS, W. Manley, London.
25,530. HARPS, J. Stein and H. Müller, London.
25,531. DEVICES for HAIR CURLING, F. C. Grocott, London.
25,532. FEEDING of SHEETS to PRINTING MACHINES, F. E. Hodgkinson and the Printing Appliances and Engineering Company, Limited, London.

24th November, 1904.

25,533. BRACE FITTINGS, T. Walker, T. Walker, jun., A. and A. E Walker, Birmingham.
25,534. REFRIGERATORS, W. Pattinson, Derby.
25,535. WHEELS for HEAVY VEHICLES, C. De Rouet, Manchester.
25,536. PLIABLE JOINTED HOOP for WHEELS, J. Bousfield, York.
25,537. PORT HOLE VENTILATORS and SIDELIGHTS, W. L. Halley, Glasgow.
25,538. DEPOSITING MATERIALS, J. M. Henderson, Glasgow.
25,539. VARIABLE SPEED GEAR, W. E. and R. J. Maddock, Stoke-on-Trent.
25,540. AUTOMATIC CANDLE EXTINGUISHER, A. C. Keeping, Boscombe, Hampshire.
25,541. AUTOMATIC FIRE EXTINGUISHER, W. A. Marshall, Bradford.
25,542. UMBRELLAS, H. and F. Constantino, Bradford.
25,543. TOWING BLOCKS, W. Wordsworth, Hull.
25,544. REST for GRINDING STONES, S. Kinlock, Weymouth.
25,545 REFUSE DESTRUCTOR, F. Wellerman, Manchester.
25,546 TREATING FLOUR, C. J. Robinson and J. Backhouse, Liverpool.
25,547. BRACELET LOCKETS, O. and J. Clarke, and A. Hawkins, Birmingham.
25,548. SELF-PROPELLED ROAD VEHICLES, E. E. Lehwess, London.
25,549. GOLF CLUBS, R. Winton, Glasgow.
25,550. RACK for HOLDING PICTURE POST-CARDS, E. West, Manchester.
25,551 DISPLAYING CURTAINS, G. P. Wadsworth, Halifax.
25,552. INSULATORS for PIANOFORTES, J. A. Derbyshire, Keighley, Yorks.
25,553. CENTRIFUGAL WHISTLE, L. G. Molteni, Milan, Italy.
25,554. WOOD CLOTHES PROP, L. Greenhalgh, Radcliffe, Lancs.
25,555. PNEUMATIC TIRES, S. Mather, Keighley, Yorks.
25,556. ATTACHMENT for CIGAR HOLDERS, F. A. Hallsworth, Ellesmere, Salop.
25,557. SAFETY-PIN for WEARING APPAREL, G. Coates, Failsbury.
25,558. BEER CLEANSER, G. Sparke, Worksop.
25,559. CONVEYORS, G and M. C. Little, Birmingham.
25,560. INJECTOR, H. J. Emuss and J. Bird, Ipswich.
5,561. No application for this number.
25,562 LAYING RAILWAY FOG SIGNALS, A. G. and A. W. Walker, and H. D. Woolley, London.
25,563. PREPARING FRUITS, J. R. Hatmaker, Paris, France.
25,564. PNEUMATIC PUMP, J. Klingelhöfer, Hamburg Germany.
25,565. TRAPS for ANIMALS, F. F. von Fürstenberg, Hamburg, Germany.
25,566. FEEDING FOOD-CUTTING MACHINES, L. Schiele, Hamburg, Germany.
25,567. FOG SIGNALS, D. and J. Mason, London.
25,568. BOXES, R. H. Pott, London.
25,569. NAVIGABLE VESSELS, A. H. P. Blunt, London.
25,570. LOOSE REED LOOMS, H. Robinson, Burnley.
25,571. PRINTERS' WOOD TYPE, R. D. De Little, York.
25,572. WATCH PROTECTOR, H. C. Ilip, London.
25,573. TYPEWRITING MACHINES, J. P. L. Donlevy, London.
25,574. MACHINE GUARD for PROTECTING FINGERS, S. F. Gaunt and W. L. Watson, London.
25,575. TOOTHACHE REMEDY, T. Murphy, London.
25,576. NUT LOCK, A. H. Wegener, London.
25,577. CLEANING KNIVES, H. Bridle, London.
25,578. COMBUSTION of LIQUID FUEL, Sir W. G. Armstrong, Whitworth and Co., Limited, E. L. Orde and W. H. Sodeau, London.
25,579. COWLS for VENTILATING SHAFTS, G. A. Maltster, London.
25,580. MAKING WOODEN WHEELS, F. W. Brampton, Birmingham.
25,581. GAS COOKING APPARATUS, T. P. Lomas and W. Barbut, London.
25,582. TRAMWAY RAIL CLEANING APPLIANCE, G. Grant, London.
25,583. VARIABLE SPEED GEAR, C. L. Schmidt and A. G. Hopper, London.
25,584. SIGHTS SUITABLE for ORDNANCE, W. Meeson, London.
25,585. SPRINGS for MOTOR CAR TIRES, W. R. V. Marshall, Barnes, Surrey.
25,586 SHAFT BEARINGS, E. R. Smith, London.
25,587. FIRE-ESCAPES, B. Johnson, J. W. Smith, and B. Johnson, London.
25,588. CHECK VALVES, J. A. Fletcher and H. Wilcock, London.
25,589. PROCESSES of PRESERVING FISH, W. Lamb, London.
25,590. MACHINE for TESTING YARN, J. Moscrop, London.
25,591. RECEPTACLE for TREATING SEWAGE, M. M. Neilson, London.
25,592. ELECTRIC SWITCHES, C. E. Hunter, London.
25,593. HANDLES of WALKING STICKS, M. J. Sexton, London.
25,594. MEANS for COLOURING WOOD, H. Becker, London.
25,595. HORSESHOES, F. F. Heiselmann, London.
25,596. BOTTLE-SEALING CAPS, A. A. Wood, London.
25,597. CASES for RAILWAY, &c., TICKETS, A. Klinge, London.
25,598. CUTTING STRING, G. Grünbaum and H. Stolpe, London.
25,599. COOKING STOVES, A. Habershon Rotherham.
25,600. DRIVING the SPINDLES of SPINNING APPARATUS, H. G. Tetley and J. Clayton, London.
25,601. MANUFACTURING FIBROUS FILTER BODIES, F. W. Stavenhagen and G. Geiler, London.
25,602. BRAIDING MACHINES, A. Le Blanc, London.
25,603. CARBURETTERS, F. L. Merritt, London.
25,604. MECHANISM for TRANSMISSION of POWER, J. Dring and C. F. Bourne, London.
25,605. CONSTRUCTION of GOLF BAGS, H. Hawkins, London.
25,606. TASSELS, M. H. Barnett, London.
25,607. WATCHMEN'S TIME RECORDER, F. E. Bensing, London.
25,608. HERTZIAN-WAVE PROJECTING and RECEIVING APPARATUS, C. Hülsmeyer, London.
25,609. GAS-OPERATED SEMI-AUTOMATIC RIFLE, M. F. Smith, London.
25,610. WIRELESS TELEGRAPHY, F. W. Howorth.—(*G. O. Squier, United States.*)
25,611. APPARATUS for PURIFYING FLUIDS, R. G. Brooke, London.
25,612. OVERHEAD TRAVELLING CRANES, A. H. Wall, London.
25,613. TROLLEY WHEELS for ELECTRIC RAILWAYS, H. J. Haddan.—(*S. W. Bates, United States.*)
25,614. CAGES for BALL BEARINGS, C. A. Hirth, London.
25,615. DRIVING GEAR for EXPLOSION ENGINES, H. Barthel and P. Modler, London.
25,616. TABLE-CLOTHS, A. Rapp and M. Seitz, London.
25,617. TALKING MACHINES, A. Vuille, London.
25,618. STEAM HEATING APPARATUS for RAILWAY CARS, E. E. Gold, London.
25,619. VALVES, E. E. Gold, London.
25,620. CONTROLLING CURRENT for POWER and LIGHT, A. M. Taylor, London.
25,621. STEAM SUPERHEATERS, W. Schmidt, London.
25,622. STEAM SUPERHEATERS, W. Schmidt, London.
25,623. WHIRLPOOL for PUBLIC AMUSEMENT, W. P. Thompson.—(*The Whirlpool Amusement Company, United States.*)
25,624. MAKING an EASILY-DIGESTED MILK PREPARATION, S. Székely and E. Kovác, Liverpool.
25,625. CONTROL of ACCUMULATOR CELLS, H. Leitner, London.
25,626. MACHINES for SLUGGING BOOTS, O. Robinson, London.
25,627. PROPULSION of MOTOR ROAD VEHICLES, L. K. Clark, London.
25,628. RAIL JOINT LOCKS, N. G. Vosler, London.
25,629. FLY-CATCHER, A. Ketzscher, London.
25,630. ELECTRICALLY-OPERATED DOORS, The British Thomson-Houston Company, Limited. — (*The General Electric Company, United States.*)
25,631. ELECTRIC CIRCUIT BREAKERS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
25,632. ELECTRIC METERS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United states.*)
25,633. REVERSE CURRENT RELAYS, The British Thomson-Houston Company, Limited. — (*The General Electric Company, United States.*)
25,634. SEALS for VACUUM TUBES, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
25,635. ATTACHMENT for TROLLEY POLES, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
25,636. ELECTRIC POWER TRANSMITTING MECHANISM, The British Thomson-Houston Company, Limited, H. S. Meyer and B. Hopps, London.
25,637. SPACE TELEGRAPHY, J. S. Stone, London.
25,638. SPACE TELEGRAPHY, J. S. Stone, London.
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25th November, 1904.

25,648. ELECTRIC GLOW LAMP, W. B. Spurrier, Newport, Mon.
25,649. REBATE INDICATOR, C. H. Brandreth and P. W. Doell, Brighton.
25,650. FLYER FRAMES, J. W. Jones and J. H. Park, Ashton-under-Lyne.
25,651. LOCKING NUTS, C. H. Dewett and W. J. Griffiths, Plumstead, Kent.
25,652. SPRINGING ORGAN PEDALS, T. E. Hughes, Manningham, Bradford.
25,653. STEAM TRAPS, R. Parsons, London.
25,654. BROOCH CATCH, J. H. Percival, Dublin.
25,655. COMPENSATING ADJUSTABLE CLAMP, A. Callenkamp, London.
25,656. FOG-SIGNALLING on RAILWAYS, J. Robinson, Barton-under-Needwood, Staffs.
25,657. FOUR-WAY VALVE, R. S. Pollard and R. W. Lodgstaff, Stockton-on-Tees.
25,658. SPOOLING THREAD, E. N. Paines and J. W. Schmidt, Manchester.
25,659. COAL-CUTTING TOOL with REMOVABLE BITS, C. Elvidge, Sheffield.
25,660. FOOD PREPARATION, H. Crocker. London.
25,661. WIND SHIELDS for USE when LIGHTING PIPES, J. Holloway, Birmingham.
25,662. ADAPTING the SPINDLES of MULES and TWINERS to RECEIVE PAPER, F. A. Holt and A. Taylor, Manchester.
25,663. OPERATING ROUTE INDICATORS, H. G. Ilman, Manchester.
25,664. CONSTRUCTION of PNEUMATIC TIRES, F. J. Flint, Brighton.
25,665. VALVES for AUTOMATIC SPRINKLER SYSTEMS, J. McAlear, London.
25,666. PAPER BAG, N. Laird, Glasgow.
25,667. LUBRICATORS, F. V. Martin and J. F. Barker, Ipswich.
25,668. VISUALLY OBSERVING DUST in AIR, J. E. L. Barnes.—(*The Sanitary Devices Manufacturing Company, United States.*)
25,669. CLOTH-FINISHING MACHINES, R. McDowell, Manchester.
25,670. SASH WEIGHTS, R. McDowell, Manchester.
25,671. TYPEWRITING MACHINES, J. D. White, London.
25,672. APPARATUS for COOKING, T. G. Hodges, Manchester.
25,673. BATHS, A. E. Salmon, Leeds.
25,674. CHIMNEY REGISTER, C. Dunn, Manchester.
25,675. TURBINE MOTORS, C. Huffam, Stockport.
25,676. SPINDLES for SPINNING MACHINES, T. A. Boyd and J. and T. Boyd, Limited, Glasgow.
25,677. COP CREELS for WINDING and WARPING MACHINES, T. A. Boyd and J. and T. Boyd, Limited, Glasgow.
25,678. LOCKS for CARRIAGE DOORS, H. Coventry, Liverpool.
25,679. STRENGTHENING WOOD BOXES, G. W. Ellis, Barnsley.
25,680. ADVERTISING APPARATUS, F. W. Richardson and J. D. Carlmark, West Bromwich, Staffs.
25,681. SAWING MACHINERY, A. Ransome, Newark-on-Trent.
25,682. ARC LAMPS, L. S. Anderson, London.
25,683. PROCESS of EXTRACTING OIL from COD LIVERS, W. R. Harrison, E. H. Wild, and A. Robb. Hull.
25,684. WEAVING LOOMS, J. Barnes and M. McGreery, Preston, Lancs.
25,685. SOLES and HEELS of BOOTS, T. H. Slack, Alderley Edge, Cheshire.
25,686. COUNTING the BOWLING in CRICKET, J. W. Colebrook. Great Grimsby, Lincolnshire.
25,687. CAP for TRAMCAR HANDLE BARS, F. Burks, E. Woodall, and W. Parkinson Manchester.
25,688. BOOTS, C. L. Watchurst and T. Leadbeater, Leeds.
25,689. MERCURY VAPOUR LAMPS, O. Schott, Jena, Germany.
25,690. HINGE, H. Rudder and J. C. Rouse, Sutton Coldfield, Warwickshire.
25,691. TREATMENT of SEWAGE, J. P. Guy, London.
25,692. BOILER SETTINGS, W. Fletcher-Eaves, London.
25,693. ELECTRICAL INSULATING CHAIRS, W. Way, London.
25,694. AUTOMATIC COMPENSATING GEAR, W. A. Granger, London.
25,695. WATER GATES, H. A. Icke, London.
25,696. MECHANICAL SCALING HAMMER, J. McLaran, London.
25,697. ALARM GONG, H. Fairbrother.—(*American Bank Protection Company, United States.*)
25,698. VAULT LININGS, H. Fairbrother.—(*American Bank Protection Company, United States.*)
25,699. CONVERTIBLE CHAIR BEDSTEAD, H. C. Lambert, London.
25,700. TRACKS for VEHICLES, P. J. and E. Ravel, London.
25,701. BOTTLES, C. von Forell, Hamburg, Germany.
25,702. FIBROUS FIRE-PROOF SHEET, J. B. Watson, London.
25,703. TREATING TEXTILE FABRICS, F. Scharmann, London.
25,704. TREATING TEXTILE FABRICS, F. Scharmann, London.
25,705. CULINARY APPLIANCE, A. C. Snell, London.
25,706. RAILWAY STATION NOTICE BOARDS, J. Challis, London.
25,707. CONSTRUCTION of GOLOSHES, R. M. Howison, London.
25,708. ELECTRIC PROJECTING LAMPS, L. Kamm, London.
25,709. POWER EQUALISING GEARS, M. Neumayer, London.
25,710. DEVICE for FOLDING FABRICS, J. Forbes, London.
25,711. REVERSIBLE CUFFS, A. Loutil and A. Guyot, London.
25,712. ICE CREAM FREEZERS, H. Lohse, London.
25,713. COATING PLATES with LEAD, G. A. Taylor, London.
25,714. HARNESS, J. B. Taylor, London.
25,715. RENDERING TIRES UNPUNCTURABLE, P. Maurri, London.
25,716. ROTARY ENGINES, P. H. Hendrickson, London.
25,717. CURTAIN POLES, C. A. Albert, London.
25,718. SENSITISED PLATES, La Société Anonyme des Plaques et Papiers Photographiques A Lumière et ses fils, London.
25,719. BURNERS for INFLAMMABLE LIQUIDS, J. Wilson, London.
25,720. FUEL ECONOMISERS for STEAM BOILERS, F. W. Green, London.
25,721. AMBULANCE LITTERS, H. H. Lake.—(*Nesseldorfer Wagenbau Fabriks Ges., vormals K. K. priv. Wagen-Fabrik Schustala and Co., Austria.*)
25,722. WAFER COATING MACHINES, A. W. Copland, London.
25,723. AUTOMOBILE SPRINGS, S. Furmidge, Liverpool.
25,724. RAIL CHAIRS, F. M. Annis, M. L. Devoir, and E. F. and B. Annis, Liverpool.
25,725. VEHICLE WHEELS, H. H Taylor, Liverpool.
25,726. PAPER MAKING MACHINES, L. M. Tailfer, Liverpool.
25,727. DEVICE for the USE of INFANTS, E. P. Scruby, London.
25,728. PROCESS of DYEING SILK, F. W. Howorth.—

(*Società Anonima Co-operativa Per La Stagionatura E. L'Assaggio Delle Sete Ed Affini, Italy.*)

25,729. DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)

25,730. DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)

25,731. COATING COMPOSITIONS, A. Baumann, London.

25,732. MACHINE for CUTTING SCREW THREADS, F. A. Meischner, London.

25,733. HYPODERMIC SYRINGES, L. Roussy, London.

25,734. BOOT TREES, C. Bencheidt, London.

25,735. BREAKERS for SPARKING DAVICES, T. Coningham, London.

25,736. TOASTING RACKS, J. Paterson and G. K. Pasley, London.

25,737. COLLAR MEASURERS, C. E. G. Wagner, London.

25,738. EXHIBITING COLOURED ADVERTISEMENTS, J. D. Stove, London.

26th November, 1904.

25,739. BEAM-WARPING MACHINES, A. Seeley, Manchester.

25,740. PNEUMATIC TIRES for MOTOR CARS, T. Davage, Sheffield.

25,741. DRAUGHT EXCLUDER for DOORS, A. E. Braden, Birmingham.

25,742. KNIFE-CLEANING SLABS, D. Cross, East Stonehouse, Devon.

25,743. FUEL ECONOMISERS, M. J. Adams, Stocksfield-on-Tyne.

25,744. MEANS of ETCHING for PROCESS ENGRAVING, M. Smith, Reddish, near Stockport.

25,745. SPRING TOOTHED HARROWS, W. Reid and A. Simpson, Aberdeen.

25,746. MECHANISM for MOTOR VEHICLES, L. R. Doran and A. Taggart, Glasgow.

25,747. COUPLINGS for SHAFTING, J. Carson, Hampton-in-Arden, Warwickshire.

25,748. SUBSTITUTE for INDIA-RUBBER, A. H. Gittings, Roseville, near Bilston, Staffs.

25,749. INSTRUCTOR for SIGNALLING, R. J. Cholmeley, London.

25,750. PORTABLE DOMESTIC SINK, J. T. Harvey, Derby.

25,751. SUPPLYING PETROL to TANKS of MOTORS, L. H. Swain, Keighley, Yorks.

25,752. COLOUR PHOTOGRAPHY, A. H. Gittings, Roseville, near Bilston, Staffs.

25,753. CHAINS, E. Nolle, Manchester.

25,754. TWO-WHEELED MOTOR CARS, A. Temperli, Manchester.

25,755. BOXES for GRANULAR SUBSTANCES, W. E. Walmsley, Liverpool.

25,756. FEEDING RODS into LATHES, J. R. Webb, jun., Birkenhead, Chester.

25,757. STITCHING MACHINES, T. H. Poynder, Manchester.

25,758. PHONOGRAPH RECORD CABINET, G. C. Drager, London.

25,759. CARRIER CYCLES, W. T. Lord, London.

25,760. FENCE STANDARDS, W. V. Gilbert, London.

25,761. NON-SKIDS for TIRES, W. J. Yapp and E. H. Girling, London.

25,762. APPARATUS for OPENING WINDOWS, J. G. Reed, London.

25,763. APPARATUS for OPENING WINDOWS, J. G. and A. E. Reed, London

25,764. ELECTRIC MOTOR CONTROLLERS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)

25,765. ENVELOPES, Kenrick and Jefferson, Limited, and F. Jefferson, London.

25,766. RINGS for SUSPENDING CURTAINS, H. A. W. Lines, London.

25,767. DRY COMPOUND of CACAO and MILK, J. R. Hatmaker, Paris, France.

25,768. GOLF CLUBS, L. Pearson, London.

25,769. ADJUSTING DEVICES for BRAKE RODS, F. E. Baker, Coventry.

25,770. ATTACHMENT for WHEEL VEHICLES, J. Thomas, London.

25,771. PUMP VALVES, O. H. C. Arendt, Kingston-on-Thames.

25,772. PHOTOGRAPHIC PRINTING FRAMES, A. Schoeller, London.

25,773. ATTACHING JAR COVERS, S. Hall and J. Fox, London.

25,774. BREWING, H. W. Gates, Sheffield.

25,775. ELASTIC FLUID TURBINES, F. Windhausen, London.

25,776. EXPANDING TAILOR'S BUST, E. Deslandes, Liverpool.

25,777. TIRES, D. C. Thomas, London.

25,778. PHONOGRAPHS, A. N. Petit, London.

25,779. BOOK HOLDER, E. Power and E. J. Gosling, London.

25,780. ROTARY ENGINES, T. W. Barber, London.

25,781. ELECTRIC IGNITION APPARATUS for EXPLOSION ENGINES, L. C. Ingram and S. R. and B. R. Cohen, London.

25,782. PIPE JOINTS, W. W. West and T. H. L. Dixon, London.

25,783. LIFEBUOYS, A. E. Edwards.—(*F. Biermann, Germany.*)

25,784. REGULATING CIRCUITS, H. Leitner and R. N. Lucas, London.

25,785. BRAKES, W. Blakeway, London.

25,786 CONSTRUCTING APPLIANCES for PRODUCING ELECTRIC LIGHT DISPLAYS, A. E. Dakhyl and A. Galanti, London.

25,787. NON-CONDUCTING PIPE COVERINGS, H. C. Michell, London.

25,788. NON-CONDUCTING PIPE COVERINGS, H. C. Michell, London.

25,789. PACKING for STUFFING-BOXES, P. Schou, London.

25,790. HOLLOW BODIES of INDIA-RUBBER, P. Schou, London.

25,791. SUPPORTING INVERTED GAS GLOBES, J. Altman, London.

25,792. WRENCHES, M. W. Brady and D. W. Althauser, London.

25,793. HAMMERS for FORGING METAL BARS, C. Vittighoff, London.

25,794. DOOR-OPENING DEVICES, G. A. Deissenrieder, London.

25,795. WET PAPER PRESS APPARATUS, A. Scheufelen, London.

25,796. REVERBERATORY FURNACES, M. Drojecki, London.

25,797. PRODUCTION of EXPLOSIVES, J. Y. Johnson.—(*Société Anonyme des Poudres et Dynamites, France.*)

25,798. MACHINES for BREAKING FLAX, C. M. White.—(*R. L. de Mola, Mexico.*)

25,799. ATOMISING MOLTEN FURNACE SLAG, F. Wynne, London.

25,800. MACHINE TOOLS, G. Mariani and C. D. Danby, London.

28th November, 1904.

25,801. REVERSING CONTROLLERS for ELECTRO-MOTORS, The Electric and Ordnance Accessories Company, Limited, R. F. Hall, and J. R. Garner, Birmingham.

25,802. ENGRAVING MACHINE, F. Cawley-Roberts, Manchester.

25,803. MANUFACTURING HORSE COLLARS, G. H. Williams, Birmingham.

25,804. SLIPS for PICTURE POST-CARDS, A. V. Terry, Birmingham.

25,805. CARDING ENGINES, J. Hetherington and Sons, Limited, and W. Reyner, Manchester.

25,806. CLIP for HOSE-PIPES, J. Plowman, Stockton-on-Tees.

25,807. SADDLES for DRAUGHT HORSES, W. Pollard, Bradford.

25,808. PRINTING MACHINES, R. Elliott and Elliott and Co. (Otley), Limited, Bradford.

25,809. HATS, F. C. Robinson, Bradford.

25,810. AUTOMATIC DRY SEAT, P. Lloyd, Southport, Lancs.

25,811. ADJUSTING PENDENT ELECTRIC LAMPS, A. C. Keeping, Boscombe, Lancashire.

25,812. TOBACCO PIPES, W. N. Christie, Edinburgh.

25,813. MACHINE for MAKING CHEROOTS, B. Fisch, London.

25,814. VALVE GEAR for GAS ENGINES, A. Alltree, Manchester.

25,815. ROOFING TILE CUTTER, A. Lucas, Poole, Dorset.

25,816. WIRE MATTRESSES, J. Sawtell and W. Buckland, Trowbridge, Wilts.

25,817. ELECTRICAL INCUBATOR ALARM, W. James, Leicester.

25,818. BAG SEPARATOR and COUNTER, T. W. A. Combes, Southsea, Hampshire.

25,819. BRACKET for SUPPORTING TRAYS, H. Bennett, Glasgow.

25,820. VARIABLE-SPEED GEAR for MOTORS, W. Carr, Bury, Lancs.

25,821. DETACHABLE SOLE PROTECTOR for HORSES' HOOFS, W. Reynolds, Cork.

25,822. SIGHTS for SMALL-ARMS, A. Tunstall, Birmingham.

25,823. APPARATUS for ILLUSORY PERFORMANCES, V. E. Johnson, London.

25,824 AUTOMATIC CHECK SIGNALLING, H. McGill, Waterloo, near Liverpool.

25,825 HYDRAULIC RAMS, W. Simpson, jun., Aberdeen.

25,826. REVERSIBLE GARMENTS, W. G. Howlett, Dorchester.

25,827. BUCKLE, W. Archer, Belfast.

25,828. SLIDING DESK and SHELF, F. C. Woolhouse, London.

25,829. COMPOSITE MATERIAL for ARCHITECTURAL PURPOSES, S. Wohle and A. M. Hart, London.

25,830. COMPOUND for use in PREPARATION of PAINTS, S. Wohle and A. M. Hart, London.

25,831. COUCH OTTOMAN BED, H. Crowther, London.

25,832. HEATING PROCESS and REVERBERATORY FURNACE, B. E. Eldred, London.

25,833. REGULATING the VOLTAGE of ALTERNATE-CURRENT GENERATORS, M. Walker, Manchester.

25,834. PROTECTING COVERS for TIRES, J. G. Grose, Coventry.

25,835. GRIP CLOTHES LINE, J. Smith and G. C. Dennis, North Devon.

25,836. PURIFYING LIQUIDS, W. Bruns, London.

25,837. BURNING CEMENT, B. E. Eldred, London.

25,838. COMB, O. Rebay and H. Sismann, London.

25,839. ELECTROLYSING APPARATUS, E. L. Thorp, London.

25,840. WEAR-RESISTING DEVICE for BOOTS, N. Weaver, London.

25,841. BURNERS for OBTAINING LIGHT and HEAT, G. Bower, St. Neots, Hunts.

25,842. CLUTCH, E. A. Angus, London.

25,843. TEMPERATURE REGULATOR for INCUBATORS, R. Law, London.

25,844. INCANDESCENT GAS MANTLES, A. Thord, London.

25,845. NATURAL HAIRPIN, L. A. Gregg, London.

25,846. AWL and STITCH GUIDE, E. Lurton, London.

25,847. JACKS, C. A. Allison.—(*A. Searls, United States.*)

25,848. TURN BUCKLES, Bullers, Limited, and A. Best, London.

25,849. SUSPENDERS for COATS, J. S. Horlick, London.

25,850. CYCLES, A. T. Wintle, London.

25,851. REMOVAL of MUD from MINES, F. Sommer, London.

25,852. HOLLOW FLOOR-BLOCK, F. Purton, London.

25,853. PHOTO FRAMES, G. S. Marris, Birmingham.

25,854. AQUATIC VELOCIPEDE, H. Davidson, London.

25,855. FLUID GAUGES, A. G. Brookes.—(*G. W. Gregory, United States.*)

25,856. GINNING COTTON, A. G. Brookes.—(*M. Prior, United States.*)

25,857. ACETYLENE STORM LAMPS, J. Margreth, London.

25,858. SEPARATING CONSTITUENTS of ORES, A. J. F. de Bavay, London.

25,859. REMOVING AIR from BOILER FEED-WATER, L. C. F. Gümbel, London.

25,860. SAFETY STIRRUPS, C. Wolff and F. Tobler, London.

25,861. WORKING a REVERSIBLE GAS MOTOR, C. Sonderegger, London.

25,862. MANUFACTURING GEAR WHEELS, F.-A. Brun, London.

25,863. PNEUMATIC TIRES, W. Vale, London.

25,864. JOINT for EARTHENWARE, C. H., E. H., and J. Bentley, London.

25,865. PORTABLE FIRE-ESCAPE, F. S. O'B. Hoare and N. H. Hamilton, London.

25,866. SHUTTLE BINDERS for LOOMS, H. B. Beckman, London.

25,867. VEHICLE WHEELS, E. Gates, London.

25,868. LIDS for JUGS, A. J. Boult.—(*D. A. D. Macmaster, New South Wales.*)

25 869. SASH HOLDERS, J. W. Wynn, London.

25,870. NUT LOCKS, W. W. Wise, I. I. Cooper, and W. L. Miller, London.

25,871. RAILROAD SWITCHES, M. M. Fitzgerald, London.

25,872. INTERNAL COMBUSTION ENGINES, P. C. Lawless, London.

25,873. FOUNTAIN BRUSH STOPPLES for BOTTLES, E. R. King, London.

25,874. REVERSING GEAR for BOATS, F. C. Blake, London.

25,875. MACHINE for VENDING POSTAGE STAMPS, R. J. Dickie and J. H. Brown, London.

25,876. JOINTS for GLAZING BARS, W. Eskstein and G. F. Pittar, London.

25,877. GAS GENERATORS, F. Neuman and J. Becker, London.

25,878. LABELLING MACHINES, L. F. and E. D. Crowell, London.

25,879. DISTILLATION of TARRY PRODUCTS, G. Wilton, London.

25,880. SCREW JACKS, A. E. Lake, London.

25,881. SPANNERS, C. Adams, London.

25,882. MANUFACTURE of BRONZE, A. Jacobsen, London.

25,883. ENVELOPES, E. Galli, London.

25,884. SILICO-CALCAREOUS COMPOSITION, C. de la Roche, London.

25,885. BEAM PRESSERS, H. Parsons, London.

25,886. RECEPTACLES and HANGERS for CLOTHING, J. W. Gilmore, London.

25,887. MANUFACTURE of BOXES, N. G. Sörensen, London.

25,888. CONSTRUCTION of ROOFS, B. Hiernaux and H. Laviolette, London.

25,889. REDUCTION of COLOURING MATTERS, J. Y. Johnson.—(*Badische Anilin and Soda Fabrik, Germany.*)

25,890. BALL THRUST BEARINGS, J. Y. Johnson.—(*Société Française des Roulements à billes, France.*)

25,891. INTERNAL COMBUSTION ENGINES, J. de Scorraille, London.

25,892. APPARATUS for BLAST FURNACES, E. Hesketh, London.

25,893. BATH, H. Kerkmann, jun., London.

25,894. TAPERS or MATCH HOLDERS, E. M. Jessop, London.

25 895. APPARATUS for HANGING HATS, E. M. Jessop, London.

25,896. MACHINES for CUTTING PEAT, O., W. K., F. W., and G. Strenge, London.

25,897. PAPER for PHOTOGRAPHY, J. Harris, P. Gillard, and H. H. Molyneux, London.

25,898. SWITCHBOARDS for ELECTRICAL SYSTEMS, B. J. B. Mills.—(*W. P. Hammond, United States.*)

25,899. COUPLING BUFFERS, F. J. Talbot, London.

25,900. SAFETY FUSES, A. G. Bloxam.—(*Roburitfabrik Witten a. d. Ruhr, Germany.*)

25,901. MANUFACTURE of BROWN MONOAZO DYE-STUFFS, O. Imray.—(*The Society of Chemical Industry in Basle, Switzerland.*)

25,902. SECONDARY BATTERIES, The Ekstromer Accumulator Company, Limited, and E. L. Oppermann, London.

25,903. DISTRIBUTION of ELECTRIC CURRENT, C. W. Atkinson, London.

25,904. MACHINES for SECURING CAPS to BOTTLES, L. Kalling, London.

25,905. SPEED GEAR for MOTOR VEHICLES, P. W. Smith.—(*A. de Kergorlay, ——.*)

25,906. RETRACTILE SEATS or CHAIRS, C. L. Claypole, London.

25,907. LACING STRIPS for CORSETS, M. K. Bortree, Liverpool.

25,908. STEELYARD APPURTENANCES, W. C. Dugdale, Liverpool.

25,909. ANCHORS, R. T. Hannay and W. Atkinson, Liverpool.

25,910. WORKMEN'S TIME RECORDERS, Recorders, Limited.—(*The International Time Recording Company, United States.*)

25,911. ALIGNING or CENTERING DEVICE, F. Jebsen, London.

25,912. GAS STOVES, L. A. Burnham, Kingston-on-Thames.

29th November, 1904.

25,913. METHOD of DEALING with ROAD or RAIL SURFACES, E. J. Christie, Ambler Thorne, near Halifax.

25,914. RAIL JOINT, W. F. Burrows, Kingston-on-Thames.

25,915. GAS STOVES, M. J. Adams, Stocksfield-on-Tyne.

25,916. PROCESS for PRESERVING SKINS, C. D. Head, Dublin.

25,917. SPAT BOOT FASTENER, T. W. E. Higgins, London.

25,918. HARDENED STEEL TIRE, T. and F. Carter, Rochdale, Lancs.

25,919. BUOY LIGHTS, F. Lister and J. Inches, Grimsby.

25,920. GAS-HEATED BOILERS, H. Slack, Accrington.

25,921. THREAD-DRESSING MACHINES, G. A. Fredenburgh, Birmingham.

25,922. BALL-and-SOCKET ROLLER, P. Finucane and J. H. Ryan, Dublin.

25,923. WEAVING LOOM MECHANISM, T. Pickles, Manchester.

25,924. MACHINES for PUNCHING HAT BODIES, The Hat Manufacturers' Supply Company, Limited, and J. Taylor, Manchester.

25,925. PISTON RINGS, P. E. Dowson, Manchester.

25,926. TRESTLE, J. H. Mayer, Milton-under-Wychwood, Oxfordshire.

25,927. SUPPORT for INCANDESCENT MANTLES, H. F. Pegden, Hull.

25,928. RING SPINNING FRAME MECHANISM, J. Hargreaves, Bolton.

25,929. RECORDING FLIGHT of PIGEONS, W. Settle, Manchester.

25,930. GARMENT SUPPORTERS, C. H. Jäger, Barmen, Germany.

25,931. COUPLING CHAIN, H. McGill, Waterloo, near Liverpool.

25,932. MOTOR GOGGLE, A. Vale, Handsworth, Staffs.

25,933. JUNCTION BOXES for ELECTRIC MAINS, R. H. Clark, Bradford.

25,934. TABLE GAMES, J. E. Betts and J. Whitcher, Rugby.

25,935. PREVENTING WHEELS SLIPPING, J. Billington, Manchester.

25,936. LOOM MOTION, J. D. Crowther and A. Sykes, Huddersfield.

25,937. COATING for METALLIC SURFACES, T. M. Hickman, Wolverhampton.

25,938 FIXING TERMINALS upon STAIR RODS, Dobbs Bros., Limited, and W. J. Dobbs, Wolverhampton.

25,939. DRY SEAT for TRAMCARS, J. E. Harris, Portsmouth.

25,940. PRUNING KNIFE, J. B. Hodgkinson, Brassington, Derbyshire.

25,941. GRADIENT INDICATOR and RECORDER, W. Gunn, Staines.

25,942. MANUFACTURE of PILE FABRICS, G. Morton, London.

25,943. TAPS for STEAM, J. B. Butterfield, Leeds.

25,944. FURNACE GRATES, D. J. Morgan, Stroud.

25,945. INCANDESCENT GAS BURNERS, H. Hateley, Erdington.

25,946. PIPE ADAPTER, J. Magee, Belfast.

25,947. HEATING STOVES, M. J. Adams, Stocksfield-on-Tyne.

25,948. MANUFACTURE of STEEL, La Société Electro-Metallurgique Francaise, London.

25,949. SECURING RESERVOIRS in LAMPS, A. F. Genton, J. R. Kessler, and J. C. F. Cleaver, Birmingham.

25,950. SYSTEM for TELEPHONE EXCHANGES, H. D. Stroud, London.

25,951. SKID-PANS, J. Sargan, London.

25,952. EDUCATIONAL APPLIANCES, J. H. Mason, London.

25,953. COMBING the FRINGES of TRAY CLOTHS, J. Drummond, Glasgow.

25,954. REVERSING of STEAMSHIPS, R. F. Yorke, Stirling, N.B.

25,955. SOUND-REPRODUCING MACHINES, H. Williamson, London.

25,956. DOOR LOCK ALARMS, A. J. Boult.—(*G. Rossi, Italy.*)

25,957. MECHANICAL PIANO PLAYERS, H. T. Logan, London.

25,958. VALVES for CASKS, G. Hallam, Coventry.

25,959. SEAT PILLARS for CYCLES, G. Gilbert and E. Mushing, Coventry.

25,960. STAIR-ROD HOLDERS, H. C. Mitchell, London.

25,961. BOTTLE HOLDERS, W. Fairweather.—(*F. Gerlach, United States.*)

25,962. CUSHION TIRES, J. H. Toole, London.

25,963. EXTENSIBLE TABLE, N. P. A. Olsen, London.

25,964. CONSTRUCTION of WHEELS, E. N. Henwood, London.

25,965. PROCESS of HOPPING BEER, A. J. Murphy, London.

25,966. APPARATUS for HEATING WATER, B. W. Davis, London.

25,967. VARIABLE SPEED GEARS, H. J. Hudson and R. J. Halls, London.

25,968. CYCLE TOE CLIPS, A. H. Kendrick, Birmingham

25,969. DOOR LOCKS, J. Wetter.—(*C. W. Bals and Co., Germany.*)

25,970. CLAMPS for BUTTONHOLE SEWING MACHINES, F. W. Ostrom, London

25,971. MIRRORS for USE in THEATRES, M. C. Murray, London.

25,972. CORDS for ELECTRICAL APPARATUS, S. S. Galsworthy, London.

25,973. APPARATUS for CHAFF CUTTERS, R. Maynard, London.

25,974. TROUSERS STRETCHERS, V. Honour, London.

25,975. PRESSES for PRESERVING FURS, V. Honour, London.

25,976. DELIVERY BOX for CIGARETTES, T. James, London.

25,977. CLOTHES LINE REEL and TIGHTENER, C. W. Ott, London.

25,978. CAN OPENERS, W. T. Secrup, London.

25,979. ELECTRO-MEDICAL APPLIANCES, P. Wenigman, London.

25,980. VEHICLE WHEELS, E. G. O'Brien, London.

25,981. BABY EXERCISERS, C. E. Latshaw, London.

25,982. MEANS for JOINTING WATER PIPES, J. F. Gage, London.

25,983. BUSHES for the BUNGS of BARRELS, W. Mills, London.

25,984. MANUFACTURE of LEATHER, The Sunbury Leather Company, Limited, and A. E. Miller, London.

25,985. AUTOMATICALLY WINDING CLOCKS, G. Hartmann, London.

25,986. POSTAL WRAPPERS, A. Matheson, London.

25,987. EXPELLING GASES from GUNS, J. D. Edwards and C. C. Love, London.

25,988. BOTTLE CORKING MACHINES, R. J. Schlosser, H. R. Fisher, and The Piso Company, London.

25,989. IMPROVED CONSTRUCTION of BRICK, T. A. Williams, London.

25,990. RATCHET SPANNERS or BRACES, F. W. Schroeder, London.

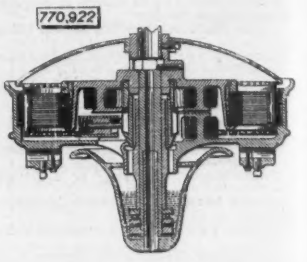
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

770,922. MOTOR, *E. S. Pillsbury and E. Bretch, St. Louis, Mo.*—*Filed April 17th*, 1903.

Claim.—(1) The combination with a driven element, and a source of electrical energy, of a main motor, an auxiliary motor, each of said motors having as elements a field and an armature, one of said motor elements of each of said motors being in driving connection with said driven element, a contact member, a brush co-operating with said contact member and electrically connected to one of said motor elements of said auxiliary motor, a circuit including said source of energy and one of said motor elements of said main motor, a circuit including said source of energy, said contact member, said brush, and said auxiliary motor element to which said brush is electrically connected, and means whereby said brush

770,922

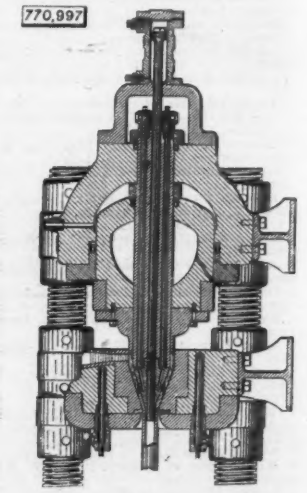


is electrically disconnected from said contact member when said main motor has been rendered operative, substantially as described. (2) The combination with a relatively fixed plate, of a rotatable plate, a motor having as elements a stator and a rotor, said stator being upon said fixed plate, and said rotor being upon said rotatable plate, a relatively fixed contact member, a source of electrical supply, electrical connection between said source of supply and said contact member, a brush carried by said rotatable plate, and co-operating with said contact member, said brush being adapted to be thrown from engagement with said contact member by centrifugal action, electrical connection between said brush and one pole of one of said motor elements, and electrical connection between the other pole of said one of said motor elements, and said source of supply substantially as described.

770,997. APPARATUS FOR THE PRODUCTION OF TUBES, *A. E. Beck and G. Townsend, Birmingham, England.*—*Filed November 24th*, 1903.

Claim.—In the manufacture of tubes direct from molten or plastic metal, the combination consisting of an operating cylinder or chamber, a central cooling core, a mandril, a die, a mould formed by the said cylinder, the core, the mandril, and die for the recep-

770,997

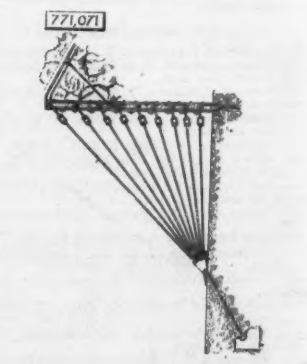


tion of the molten or plastic metal, an annular ram, a hydraulic cylinder and connections adapted to reciprocate the said mandril, and hydraulic cylinders and connections adapted to reciprocate the said ram in the said mould whereby the metal therein is subjected to repeated compressive workings and gradually carried step by step through the mould and discharged therefrom in a continuous length, substantially as described.

771,071. METAL DAM, *J. L. Holmes, Butte, Mont.*—*Filed October 28th*, 1903.

Claim.—A metal dam comprising a transverse dam structure having a facing and embedded at its bottom

771,071



in the bed of the waterway and embedded at its ends in the sides of the waterway, and a bracing anchored upstream in the bed of the waterway and connected with the said dam structure, as set forth.

THE BRITISH AND AMERICAN LOCOMOTIVE EXPORT TRADE.

By W. POLLARD DIGBY.

STOCKTAKINGS on an Imperial scale—operations recommended by Lord Rosebery in a celebrated address in a Scottish city—are the order of the day. Protectionists and Free Traders delve into export and import returns, incidentally to measure the progress or retrogression of specified industries, but more generally to find fuel for the fiscal controversy. Perhaps a few statistical notes concerning the pre-eminently British industry of locomotive building may be of interest to engineers. The writer does not pretend to quote each and every figure, but, by reviewing the subject with as little bias and as little partiality as is possible at a time when every student of statistics is tempted to become partisan, hopes to present the most important figures in the course of this article. The pointing of morals, and adorning of tales, must be left to the reader.

This pre-eminently British industry, hall-marked with the names of Trevithick and Stephenson, has, in its facilitation of transport, carved out fresh centres and streams of industry as clearly and distinctly as the railroad builder has built his embankments in the valleys and scored his cuttings among the hillsides. That in newer lands with abundant water-power the electric locomotive threatens its supremacy; that even in the suburbs of Newcastle, Liverpool, and London the side-tank engine pulling its train of coaches will give place to electric trains, is not yet indicated by such statistics as are available.

Broadly speaking, these statistics may be divided into two classes — those concerned with the external export trade, and those concerned with the demand of our great trunk lines. To the mass of the general public both statistics and commerce seem now to spell the former, for their figures are the more easily available and a great deal more frequently quoted. Most investigators stop short at the statistical abstracts issued by the Board of Trade. Those who study export and import returns in their minutiæ and inspect the detailed trade returns may be surprised to learn that a matter of such infinitude as an export of £24 worth of bedsteads to British Burmah in one particular year is duly chronicled. A detailed consideration of the individual countries purchasing locomotives would be too long for the present article. Taking the general classification of (*a*) exports to foreign countries, (*b*) exports to British Possessions, and (*c*) total exports, these are given year by year since 1888, and also triennially in Tables I. and II. Comparing the first and last triennial periods, it is interesting to note the complete reversal of the relative importance of the two markets. Roughly speaking, one-third of the exports went to the colonial and other dependencies in 1888-90, while two-thirds are so distributed in 1900-1902. The total trade in the last triennial period seems in a very healthy position indeed. The depression which existed between 1892 and 1896. the high-water mark of the purely foreign trade in 1890, and other abnormal years are best noticed in Table No. I. Table No. II. gives the triennial average export to these markets. These two broad divisions require further elucidation; the writer has therefore sub-divided the foreign market into (I.) the European, (II.) the South American, (III.) the Asiatic, (IV.) the North American:—

TABLE I.—*British Locomotive Exports.*

Year.	Exports to foreign countries.	Exports to British Possessions.	Total exports.
	£	£	£
1888	598,831	425,613	1,024,444
1889	1,056,376	387,239	1,443,615
1890	1,334,000	514,462	1,848,462
1891	880,369	736,885	1,617,254
1892	504,054	479,698	983,752
1893	321,277	521,383	842,660
1894	466,313	283,273	749,586
1895	430,488	367,359	798,027
1896	580,965	496,858	1,077,823
1897	499,917	506,219	1,006,136
1898	660,627	822,973	1,483,600
1899	522,951	944,438	1,467,386
1900	755,836	741,013	1,496,849
1901	691,949	1,219,391	1,911,340
1902	517,275	1,781,904	2,299,179
1903	567,188	1,791,512	2,358,700

TABLE II.—*Triennial Averages.*

Three years ending Period.	Average exports to foreign countries.	Average exports to British Possessions.	Average total exports.
	£	£	£
1890	996,420	442,428	1,438,840
1893	568,566	579,322	1,147,889
1896	492,589	382,496	881,812
1899	561,165	758,876	1,319,041
1902	655,020	1,280,769	1,902,456
1903 (one year only)	567,188	1,791,512	2,358,700

TABLE III.—*Average Locomotive Exports to*

Period three years ending.	European countries.	South American countries.	Asiatic countries.	North American countries.
	£	£	£	£
1890	209,149	598,134	99,459	26,222
1893	206,728	257,520	49,083	27,902
1896	107,708	200,053	129,706	21,202
1899	118,232	135,809	169,375	7,755
1902	203,521	243,238	122,728	18,866
1903 (one year only)	58,795	229,442	178,540	—

The colonial market has been sub-divided into six groups—(1) British West African, (2) British South African, (3) Australasia, (4) British East Indies, (5) British West Indian Islands, and (6) other British Possessions. While such geographical sub-divisions as have been adopted are somewhat arbitrary, they serve to minimise as far as possible differences of distance between the colonial market and the various locomotive manufacturing countries.

TABLE IV.—*Distribution of Locomotive Exports to British Colonies.*

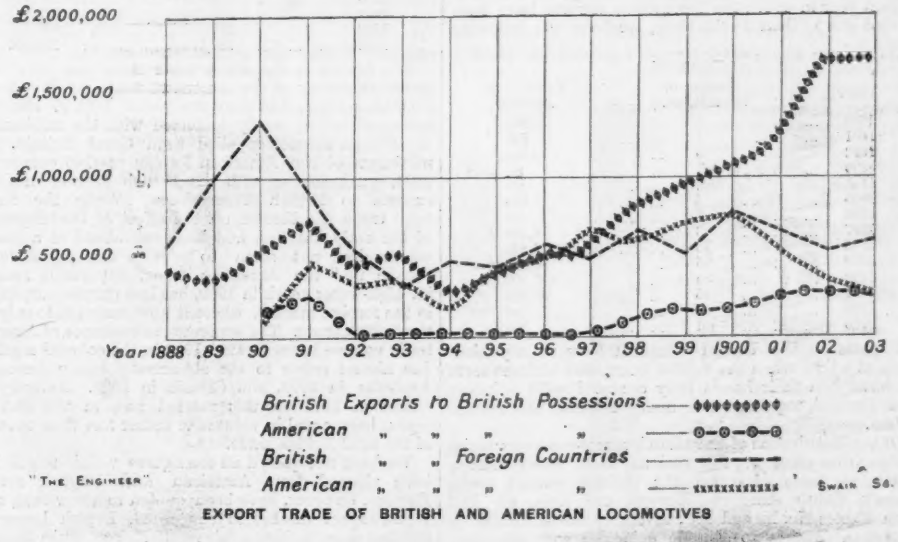
Year.	British West Africa.	British South Africa.	Australasia.	British East Indies.	British West Indies.	British North America.	Other British Possessions.
	£	£	£	£	£	£	£
1888		9,425	86,076	302,774	—	17,135	10,203
1889		78,605	147,705	130,512	8,943	—	21,476
1890		147,357	151,081	191,708	5,442	—	18,874
1891		78,995	308,385	326,823	6,356	—	16,326
1892		97,171	216,682	257,153	3,214	—	2,648
1893		81,037	85,582	346,753	3,626	—	5,385
1894		21,231	49,783	204,091	1,977	—	6,191
1895	50	4,244	46,666	305,535	5,670	—	5,374
1896	3,858	118,729	164,887	186,009	4,378	—	17,507
1897	143	81,915	181,026	233,523	3,858	—	5,754
1898	18,896	60,678	264,486	451,679	2,166	—	24,500
1899	6,307	55,554	108,888	762,178	2,532	—	15,266
1900	5,776	80,064	206,298	431,682	3,223	—	13,979
1901	33,960	280,168	350,323	515,015	14,960	—	24,875
1902	67,834	473,307	423,634	788,401	1,663	—	25,065
1903	17,989	590,260	351,682	588,041	1,166	202,721	39,763

TABLE V.—*Average Locomotive Exports from the United Kingdom to*

Period three years ending	British West Africa.	British South Africa.	Australasia.	British East Indies.	British West Indies.	Other British Possessions.*
	£	£	£	£	£	£
1890	—	78,462	128,247	171,663	7192†	22,563‡
1893	—	85,734	203,216	309,910	3502	8,130
1896	1,954†	48,068	87,112	231,878	4008	9,357
1899	8,449	66,049	151,800	482,460	2852	15,173
1902	15,523	233,418	264,752	518,363	6615	21.306
1903 (one year only)	17,989	590,260	351,682	588,041	1166	39,763

* Including Canada, Newfoundland, and remote districts not separately enumerated. † Two years only. ‡ Includes £17,135 British North America, separately distinguished in 1888 only.

An analysis of the foregoing tables will show that, in regard to the foreign trade, the most noticeable falling off


£2,000,000
£1,500,000
£1,000,000
£500,000
Year 1888 89 90 91 92 93 94 95 96 97 98 99 1900 01 02 03
British Exports to British Possessions
American " " " "
British " " Foreign Countries
American " " " "
"THE ENGINEER"
SWAIN Sc.

EXPORT TRADE OF BRITISH AND AMERICAN LOCOMOTIVES

is in regard to the South American market. It seems that the depression is now over, and that we may look for a continuance of improved trade. The figures for Europe also show a recent improvement. The Asiatic figures fluctuate rather violently, while the North American trade is practically negligible. The colonial figures serve to epitomise recent colonial history; for instance, the rise of West Africa due to the mineral wealth of Gold Coast hinterland, the low value to which the Australian demands fell between 1893 and 1895 due to the financial crisis of that period. In an examination of Table No. 4 we see clearly the effect of the war on the South African trade. The apparently high average value of £233,418 for the three years ending 1902 quoted in Table V. is made up from the widely separated figures of £80,064, £280,168 and £473,307. A glance at the figures for the British East Indies shows depressions due in part to the famines of 1897 and 1900. Other depressions are due, of course, to variations in the demand—fluctuations which some attribute to a lack of foresight on the part of the Indian railway authorities. That trade group which is embraced by the term "British East Indies" of India, Ceylon and the Straits Settlements, has been throughout chief among the purchasers of British locomotive exports. During 1902, the last year but one covered by our review, they have amounted to no less than £788,401, a sum greater than that covered by the whole of the colonial trade in any year prior to 1898. It also exceeds the sum of the whole of the foreign trade for any year since 1891. The percentage of the whole trade for 1902 embraced by the exports to the British East Indies is 34·4 per cent., and 44·2 per cent. of the colonial trade. The chief feature of the trade of 1903 is the continued high value of the exports, despite the decrease of the continental trade. The South American and Asiatic markets show slight changes, while the total of the colonial market is stationary. A great reduction in the export to the British East Indies has been counterbalanced by the sudden spring into prominence made by Canada, which took locomotives to a value of £20,272.

The locomotive import trade into Great Britain does not call for much space. The figures, which have unfortunately only been computed since 1901, are as follows:—

Year.	£
1901	62,619
1902	15,501
1903	16,542

The British locomotive industry is singularly different from that of the United States or Germany. While one or two of our railways at times buy locomotives from North British or Midland firms, their general practice has lain in the building of their own engines. Swindon, Crewe, Gateshead, Stratford, Doncaster, Brighton, Ashford, and Nine Elms are only some of the names which occur in this connection. Here works are equipped, not only for the repair of locomotives and rolling stock, but also for the varied types of side and saddle-tank, four and six-coupled, or single-driver engines which the line requires for its different sections. Out of this individualism—an individualism which is distinctly British—has been evolved such finely economic and efficient engines as the Webb compound, the Ivatt coupled, and the Stirling single-driver locomotives. While this individualism made on the whole for efficiency, individualism seemed to run riot throughout the foreign and colonial markets. As if the fads for which Great George-street is occasionally responsible were not enough, the varied requirements of the flat, low-lying parts of Holland, the hill districts of India, the jungles of Uganda, the broad plains of the South America Republics, and the deserts of the Soudan have produced a variety of demand, which has rendered building standardised locomotives for stock well-nigh impossible. The United States, on the other hand, are the home of some large locomotive building companies, and the various railway companies, instead of building distinctive types such as are found best suited to their individual needs on the railways in the United Kingdom, purchase engines denoted in the most recent returns as Class C2, OOoo > or Class A3, OOO >. In Germany, although the State owns the railways and repairing shops, the building of new locomotives is the perquisite of firms at Hanover, Cassel, and other places.

To measure the volume of the home locomotive trade is no easy matter. While the railway returns of the Board of Trade give the total number of locomotives owned by the railways of the United Kingdom, and while it is possible to obtain the actual total of the net additions in any one year, we cannot tell what is the gross number or value of the additions, or what number has gone to the scrap heap. The number of locomotives owned by the railways in the United Kingdom is given in Table VI.

TABLE VI.

Year.	No.	Year.	No.
1888	15,694	1896	18,956
1889	15,924	1897	19,479
1890	16,237	1898	19,914
1891	16,860	1899	20,570
1892	17,439	1900	21,304
1893	18,032	1901	21,823
1894	18,328	1902	22,130
1895	18,658	1903	22,385

The average annual increase in numbers was 181 per annum in the three years ending 1890, 598 in the three years ending 1899, 553 in the three years ending 1902, and only 255 for 1903.

The railway returns of the Board of Trade also give the total cost in the United Kingdom for the materials used and wages paid in each year since 1897 for the repairs and renewals of engines. Prior to this year these figures were not separately enumerated. Such figures as are available are given in the following table:—

TABLE VII.

Year.	Materials for repairs and renewals of engines.	Wages for repairs and renewals of engines.	Total cost of repairs and renewals of engines (col. 1 + col. 2).
	£	£	£
1897	1,497,947	1,804,303	3,302,539
1898	1,585,125	1,877,592	3,462,717
1899	1,780,622	1,987,672	3,768,294
1900	1,998,846	2,057,580	4,056,426
1901	2,092,062	2,105,693	4,197,755
1902	2,151,592	2,151,592	4,370,454
1903	2,163,000	2,255,000	4,418,000

These figures, presumably, do not cover purchases

made by the railway companies of complete locomotives from English and foreign builders. Even should these purchases prove to be included, it is well worthy of note that in 1902 the cost of repairs and renewals of locomotives for our trunk lines is eight times that of the value of locomotive exports to foreign countries, two and a-half times that of the colonial locomotive trade, and nearly double that of the entire locomotive export trade.

So much for the British locomotive industry. The only country in the world possessing more locomotives than the United Kingdom is the United States. With a population nearly twice as numerous, with an area twenty-four times larger, it is in no way surprising to learn that the aggregate number of locomotives possessed by the United States at the end of 1901 amounted to 39,584, and had increased in number at the rate of 1100 per annum for the preceding three years. A great deal can be written respecting American internal locomotive statistics. For instance, the amounts spent by the American railway companies in repairs and renewals of locomotives during the year ending June 30th, 1902, was £16,148,000. At the same time, the American locomotive export statistics are admirably chronicled. The following table gives the total exports since 1888:—

Table VIII.

Year.	Number.	Value in £ sterling.
1888	56	81,403
1889	144	245,430
1890	161	256,121
1891	275	484,873
1892	197	343,543
1893	195	349,942
1894	142	205,667
1895	252	475,904
1896	261	502,450
1897	338	645,166
1898	468	756,744
1899	517	945,749
1900	525	1,118,481
1901	423	807,801
1902	365	651,559
1903	289	543,956

Contrasting the two sets of export figures, it may be observed that for the three years ending 1902 the average exports from the United States to all sources were valued at £859,280, or less than half the average value of the total British exports during the same period. The manner in which the American locomotive exports have been distributed is worthy of a brief investigation. Taking, first of all, that of the United Kingdom, starting from 1890, the earliest year in which the locomotive exports have been divided among their destinations, we have the following record:—

Table IX.

Year.	Number of locomotives.	Value in £ sterling.
1890	1	4,900
1891	1	540
1892	5	9,840
1893	nil	nil
1894	nil	nil
1895	4	5,675
1896	nil	nil
1897	3	4,450
1898	10	13,845
1899	25	56,299
1900	84	207,102
1901	15	35,910
1902	nil	nil
1903	nil	nil

Exports to the United Kingdom have mainly taken place at a time when the British locomotive builders seem to have had their hands fully occupied with a heavy local demand, together with heavy colonial and foreign orders.

Of the distribution of American locomotives to countries within the chief of the various trade zones, among which we have classified the British export trade, namely, South America, Europe, and Asia, we find from Tables No. X. and XI., that the recent decline of American exports to Europe coincides with the slight British rally in this sphere, the American maximum also coinciding with the British minimum.

Table X.

Year.	South America.	Europe.	Asia.
	£	£	£
1890	140,639	10,100	1,600
1891	195,607	1,840	8,040
1892	195,144	13,560	8,520
1893	98,962	nil.	23,116
1894	342,557	1,300	32,041
1895	209,800	6,800	34,632
1896	100,766	181,409	184,065
1897	101,183	123,880	280,973
1898	47,298	109,389	352,926
1899	48,321	199,872	246,804
1900	4,528	240,142	97,396
1901	48,061	166,758	74,432
1902	119,409	20,022	28,270
1903	36,846	5,120	55,008

In regard to South America it may be noted that, despite proximity, the American exports have never equalled the value of the locomotive exports from the United Kingdom; while in the period of South American depression, the exports from the United States fell to a very low value, from which there has hardly been any rally which can be contrasted with the improvement in British exports to this market.

As to the distribution within the chief British sphere of colonial or possessional influence, we have the following figures:—

Table XI.—*Value in £ Sterling to respective Trade Zones.*

Year.	British South Africa.	British East Indies.	British Australasia.	British North America.
1890	nil	nil	2,652	6,365
1891	nil	nil	146,475	13,535
1892	nil	nil	nil	1,343
1893	nil	nil	nil	4,320
1894	nil	nil	nil	21,785
1895	nil	3,850	nil	7,806
1896	5,728	nil	nil	2,965
1897	1,000	nil	nil	13,163
1898	15,340	2,687	3,880	108,070
1899	1,380	81,790	nil	79,480
1900	6,000	63,369	5,730	79,725
1901	54,000	20,724	51,260	123,372
1902	8,260	14,500	130,314	134,967
1903	52,056	nil	nil	228,025

These figures show that American competition in these spheres is generally far more sporadic even than in the South American market; that in British South Africa the trade is not considerable; that while the American export of locomotives to the British East Indies reached its zenith in 1899, this trade has dwindled remarkably to zero in 1903, perchance to reappear if ever British manufacturers be not too full of orders to guarantee speed delivery; that the Australasian trade reached a maximum in 1902; and that the only exception appears to be British North America, which we might have almost regarded as the preserve of the United States manufacturers had it not been for the remarkable British export of over £202,000 value sent from the United Kingdom in 1903.

A last comparison, and our review of some of the locomotive statistics of Great Britain and the United States is completed. Our examination of the British figures began with the Board of Trade's broad division into "exports to foreign countries" and "exports to British Colonies and Possessions." The total exports from United States have already been given. If we re-classify these exports as exports to British Colonies and Possessions and exports to foreign countries other than Great Britain, we obtain the following table and diagram:—

Table XII.—*American Locomotive Exports.*

Year.	To British Colonies and Possessions.	To foreign countries (other than Great Britain or British Possessions)
	£	£
1890	149,680	101,541
1891	23,840	460,493
1892	14,063	319,640
1893	4,383	354,539
1894	26,206	179,461
1895	11,656	458,573
1896	9,193	493,257
1897	14,163	626,553
1898	129,977	612,922
1899	169,379	720,071
1900	170,145	741,235
1901	249,256	522,635
1902	288,041	363,518
1903	280,091	263,865

The figures in the above table show the very spasmodic character of the American trade to the British colonial market, and that the period 1891-97 showed a falling off which nearly coincided with the minimum in the foreign market supplied from Great Britain. The minimum of the American foreign market occurred in 1894, synchronising with the British year of minimum exports to British Possessions. While the British total trade has thrown off the effect of the depression of the early nineties, and has gone ahead in a manner which does not seem to require any adjuration to "wake up," the American trade, apparently reaching its high-water mark in 1900, has lost ground surprisingly in the foreign market, where it now amounts to only half the British trade. The apparent maintenance of American trade volume between 1901-1903 in the colonial market is due almost solely to the abnormally heavy demand of Australia in 1902, and Canada in 1903. Actually, the American hold on this market has, in the last two years, been equal in volume to rather less than one-sixth of the total British trade.

We have not quoted all the figures which might have been gleaned from American and English returns. Enough, however, have been quoted to show that, so far as the export market is concerned, British locomotive builders seem to hold a fair repute. Too much emphasis ought not to be laid on export figures. In both cases the home demand vastly outshadows the export trade. Dealing with numbers of locomotives only for America, the average annual increase in locomotives, for the three years ending 1901, was 1100, while the average number of locomotives exported in the same three years was 495. Dealing with values only for the United Kingdom, the sums expended for materials and wages for locomotive renewals have latterly been about twice the value of the exports. The pointing of further morals, or the adorning of fiscal tales for controversy, is perhaps best left to the individual reader.

THE PREMIER (TRANSVAAL) DIAMOND MINE.

By Stafford Ransome, M. Inst. C.E.

My excuses for giving a description of the Premier (Transvaal) Diamond Mine at the present time are:—(1 It is by far the largest diamond field ever discovered. (2) The conditions under which it will be worked differ somewhat from those obtaining elsewhere. (3) Orders for machinery and plant to the amount of about a quarter of a million sterling have already been given out for this mine. (4) The whole of these orders, with the exception of the belt conveyors, have been placed with English manufacturers. (5) The contracts already given out are only forerunners of others that are to follow.

Although just now it would be premature to give a detailed account of the machinery to be employed, and the design and arrangement of the plant, I have mentioned above five valid reasons why the British engineer, and especially the manufacturing engineer, should be able to form an appreciation of the importance of this wonderful mine.

To begin with, it must not be confounded with the Premier Mine at Kimberley, which is one of the De Beers group. The Premier (Transvaal) mine is situated close to Pretoria, and the first suggestion of the existence of diamonds at that spot was made in 1897.

"If you sit down on the crest of the southern Elandsfontein hills, and look out on the veldt in front of you, you cannot help seeing another Kimberley," said one "Jim" Pippin, a practical mining expert to Mr. Leo Weinthal, in March, 1898. That prophecy has now been fulfilled, for the country thus referred to was the site which the Premier mine occupies to-day. And the area of this one blue "pipe" is more than large enough to contain the combined areas of the whole of the De Beers group of Kimberley mines.

About two years ago, when I was acting as Special Commissioner of The Engineer in South Africa, I had occasion to suggest that in this Pretoria mine the De Beers Company would for the first time come face to face with an important competitor. In a year from now that event will have come to pass, for when the plant now on order is fully at work the output at the new Premier Mine should be at the rate of something over two million pounds worth of diamonds per annum.

In 1898 the property now covered by the Premier (Transvaal) Mine could have been bought for £25,000 from the Boer farmer, Herr Joachim Prinsloo, whose little daughter owned it. But Boer like, he would not allow the vestige of a prospect to be made, and so the Johannesburg magnates could not be induced to find the money. Murder will out, however, and just before the war enough became known of the value of this property to make certain people eager to possess it. The war, however, stopped all negotiations, and when peace was declared, three years later, the slim Joachim doubled his price, and then added another £5000. The property was eventually bought for £55,000 by Mr. Thomas Cullinan and a few friends, and prospecting was really only started on at the beginning of 1903.

This mine at the surface is situated in a shallow oval hollow, suggestive of the crater formation, noticeable with many of these blue pipes, and its workable area covers 4002 surface claims of 30ft. by 30ft. The formation is proved to be that of the true diamond pipe, a core of erupted diamondiferous blue ground ascending in an irregular section to the earth's surface, with a "horse," or core of barren rock, running up the centre.

Though stones of the best quality have been found at the Premier Mine, the general run of the diamonds recovered is not of a very high grade, mainly, I understand, owing to the nature of their crystallisation. Such as they are, however, they command a ready market at an average rate of 27s. per carat. The yield up to the present comes out at the rate of about nine-tenths of a carat per load, and the cost of mining does not exceed 2s. 6d. per load.

Below I give in tabular form the results of working, by the rough-and-ready methods that are now being used at this mine, for the first nine months of this year:—

	Loads washed.	Yield, carats.
January	34,618	32,056
February	47,156	41,524½
March	63,715	49,349
April	102,755	74,561
May	111,210	75,891¼
June	107,848	67,007
July	98,190	83,537¾
August	117,954	102,967¾
September	119,800	89,655
October	97,311	81,709

Though the above table shows something less than one carat to the load, it is claimed that a certain portion of the property will yield 5 carats to the load. Certain it is that when the elaborate plant now on order is in operation the percentage of diamonds saved will be greater than at present, and the yield per load consequently greater than by the existing means.

There are many important economic factors in connection with this mine which allow of its being worked at a lower cost than any other. First, it is in the heart of the coal-producing centre of the Transvaal, and its fuel will be obtained at the cheapest possible rate. Then the blue ground at Pretoria is far more friable than that at Kimberley. The compression at the great depths from which Kimberley is drawing most of its diamonds is so intense that the blue ground recovered is to all intents and purposes hard rock. Before this ground can be treated by the crushers it has to be laid out on "floors" and exposed to the weather for twelve months, and to maintain the autonomy of their working the De Beers Company are obliged to keep a running stock of blue ground representing four millions of pounds worth of diamonds continually on these floors. The cost of handling this vast quantity of stuff, carrying it from the pit head to the floor, dumping it there, turning it over from time to time, and then bringing it back to the machines, the huge space required, the enclosing of it, the maintaining and guarding of the extensive boundaries, the hauling appliances, and the army of "boys" entailed in this process, will all be avoided at the new Premier Mine as the ground there is sufficiently tractable to be crushed by the machinery as it leaves the mine.

The average cost of underground mining at Kimberley for the last three years is just over 8s. per load, and of surface working just over 3s. 3d.

The saving to be effected by the Premier Mine on the above figures would seem to be based upon: (1) Cheaper coal; (2) no underground mining; (3) softer ground; and (4) improved appliances. Though the area of the Premier pipe is so great that there need be no question of underground working for scores of years to come, it is as well to give the facts and estimates as to its possibilities. The blue ground has been proved by bore holes to the depth of 1000ft., and diamonds have been extracted at 500ft. As this mine, however, is of the pipe formation, there is no reason to suggest that the blue diamondiferous formation does not run down indefinitely into the earth; that is to say, beyond the limits of practical deep mining as known to-day. There are said to be 20,000,000 loads of ground "in sight" at the present time, and that, working

the mine out to a depth of 400ft., 100,000,000 loads will be obtained. Even at that depth this mine will not have reached one-sixth of the depth already attained at Kimberley. It is for these reasons that I recommend the manufacturing engineer to keep his eye on this mine and its requirements; for assuredly a second, and possibly a larger Kimberley, has been found, and it must prove a good and permanent market.

At the beginning of this article I stated that the time had not come for a detailed description of the plant. This is due to the fact that several of the machines are said to contain new features which for the moment are in process of elaboration. As this plant, however, is, with the exception of the belt conveyors, which are being "made in Germany," all British, I give below a list of the machines and appliances and the firms who are making them:—Messrs. Mechan and Co.: Steel buildings, coal bunkers, tanks. The Clyde Structural Iron Co.: A steel building, a crane. Messrs. A. F. Craig and Co.: Hauling gear. Messrs. F. and W. Smith: Wire ropes. The Hadfields Steel Foundry, Limited: Crushers, gyratory type. The Chatteris Engineering Company: Crushing rolls—McLelland's patent—grizzleys, pulsators, water chutes, pudler rolls, automatic greasers, grease tables. Messrs. Fraser and Chalmers: Washing machinery. Messrs. Tangyes: Pumps for washing plant. Mr. G. F. Zimmer, Germany: Belt conveyors. Messrs. Osborne and Co.: Carrying drums and shafts. Mr. J. Adamson: Cranes. Messrs. Cole, Marchant and Morley: Main driving shafts and pulleys. Messrs. Crompton and Co.: Electrical power and lighting plant, including Bellis engines. Messrs. Babcock and Wilcox: Main boilers. Messrs. Fullarton, Hodgart and Barclay: Main driving engines. Messrs. Marshall, Sons and Co.: Workshop engine and boiler. The machine tools are divided between a variety of firms.

The total weight is about 4000 tons, and most of it is due for shipment early in the year. The whole plant should be in full swing by January 1st, 1906. It is satisfactory to note that, in spite of the keen competition for South African orders and the oft-alleged shortcomings of the British manufacturer, practically the whole of this large order has been placed in his hands. One thing, however, I should like to know, for I have worried over it for more than two years and can find no solution—Why is it that we cannot secure orders for belt conveyors in England?

THE INTERNATIONAL EXHIBITION AT ST. LOUIS.

No. XXIV.*—STEAM TURBINES.

The mechanical exhibits at the St. Louis International Exhibition include a number of steam turbines, representing four different makes. The De Laval, the Curtis, and the Parsons-Westinghouse turbines are well known, but the fourth is a new type and is actually the first of its type ever built. It is the design of Mr. Holzwarth, of the Hooven, Owens and Rentschler Company, which company also exhibits its first vertical Corliss engine, and this has already been described in The Engineer of September 2nd. Much has been heard of this machine, which was not installed until long after the Exhibition was opened, and it was generally supposed that it was to be a Rateau turbine of American construction. This, however, proves not to be the case. It is a compound turbine with high and low-pressure sections mounted on a horizontal shaft which carries the generator. It runs at 1500 revolutions and has a normal capacity of 1000 kilowatts, with a maximum capacity of 1500 kilowatts. It drives a Bullock three-phase generator of 6600 volts, 25 cycles. The turbine portion of the unit is 24ft. 3in. long and 7ft. 3in. wide, weighing 86,000 lb.; the entire unit, including generator, is 40ft. 3in. long, 9ft. 8in. wide, and weighs 162,000 lb. It is designed to work with 185 lb. initial steam pressure and 28in. of vacuum. Fig. 1 is a view of the complete machine.

The Holzwarth turbine is of the same class as the Parsons, Rateau, and Curtis machines, being of the multi-stage axial flow type; it has a number of stationary discs and running wheels, both of these having vanes around the circumference. But, while in the Parsons turbine the steam is expanded in both the discs and the wheels, the Holzwarth turbine gives expansion only in the stationary discs, the radial depth of their vanes being increased to provide for the increased volume of steam due to expansion. The number of wheels is less than in the Parsons type, and no balance pistons are required, as the steam pressure is practically the same on both sides of the running wheels. The thrust of the shaft is therefore so small that it is easily taken by a ball-thrust bearing.

The steam passes through a separator, an inlet valve, and a regulating valve, and then enters the high-pressure section of the turbine. From the ring channel in the turbine head the steam flows through the first set of stationary vanes, which are rigidly attached to the head; these give it a tangential direction and give the necessary velocity by a partial expansion. The steam then flows in a full cylindrical belt, interrupted only by the vanes on the first running wheel; thence it goes to the next stationary disc, and so on to the end of the casing; it is then led to the low-pressure section, through which it passes in the same way. This section, however, has an additional nozzle for the admission of live steam in case of overload. This admission is controlled by the governor, and it exerts no back pressure to the steam from the high-pressure section, but rather serves to induce the flow of the latter. The stationary vanes have a varying radial height, increasing in the direction of the flow of steam, thus allowing the steam to expand within the vanes. At the same time they guide the steam under such a small angle that the force with which the steam impinges upon the vanes of the adjacent running wheel is as effective as possible. The vanes are of drop-forged steel, milled to shape and secured by rivets. When they are in place the disc and vanes are ground on the outside edges, and a steel ring is shrunk around them. From the low-pressure section the steam goes to the condenser.

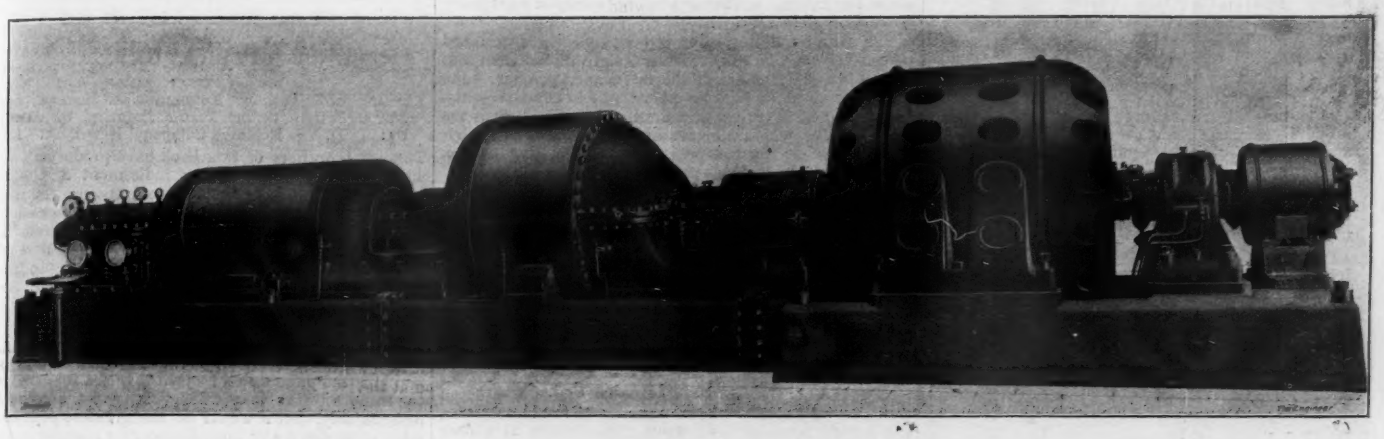


Fig. 1—HOLZWARTH STEAM TURBINE

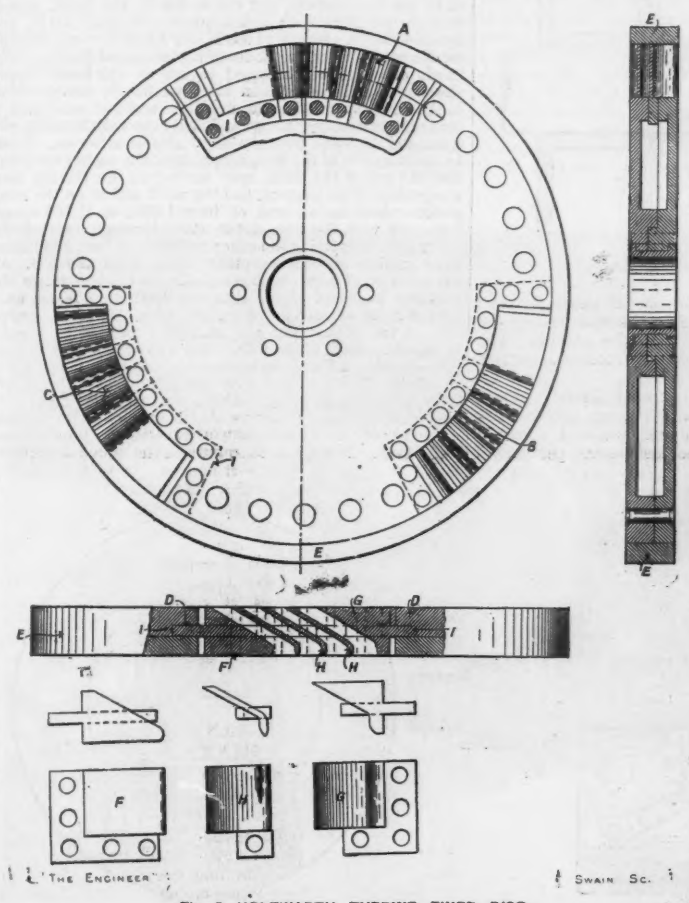


Fig. 2—HOLZWARTH TURBINE—FIXED DISC

As already explained, the turbine has a series of stationary discs and revolving wheels, both of which have their rims fitted with blades or vanes. Fig. 2 is a view of one of the stationary discs, with three sets of nozzles, and a part of the surface removed to show the adjustment of the nozzle section. The disc is composed of two plates bolted together, and having segmental openings, as shown at A, B, and C. The inner face of one plate is recessed at D, along the sides and ends of the segmental openings, so that when the plates are bolted together a groove is formed in the side and end walls of the openings. A ring E encircles the disc. The nozzle passages are situated in the openings A, B, and C, their shape and size being determined by nozzle members F, G, and H. The members F and G are adjusted to the ends of the openings and have projecting flanges I, which fit into the channels at the ends and bottom of the openings formed between the discs. The intermediate members H have angular flanges fitting the recesses at the base of the openings. These flanges are secured in position by rivets. The forms of these three types of nozzle members are also shown enlarged in Fig. 2.

One of the revolving wheels is shown in Fig. 3, and in their design it is important to keep them as light as possible. Each wheel is built up of two steel plates bolted to a cast steel sleeve mounted upon and splined to the shaft. The outer edges of the plates are flared out to form flanges and are riveted together, with spacing blocks between the flanges and spacing sleeves at the wider part. The spacing blocks carry the vanes, which have lips entering the channels A A in the blocks, while the sides of the vanes rest upon the flanges of the wheel. A band B encircles the edge of the wheel, the outer edges of the vanes being recessed to receive this band. The vanes are milled on both edges.

The bearings for the turbine shaft are made with cylindrical shells, but those for the generator shaft—having greater weight to carry—have spherical shells to ensure their alignment. The oil is fed to the bottom bushings under a slight pressure, and flows with the rotating shaft up to the cap, whence it flows back to the oil outlet. The three shafts—for generator and high and low-pressure sections—of the turbine are connected by flexible couplings. A special form of bearing is used to prevent the leakage of steam along the shaft and the leakage of oil from the bearing into the turbine. This is shown in Fig. 4. A sleeve A is secured to the shaft by set screws, and projects into an annular recess in the collar B, which projects from the head of the turbine casing, being fitted against a packing ring C, which prevents leakage at this point. Inside the collar is a packing around the shaft at D, which is set up by a threaded sleeve or gland to form a stuffing-box. Upon the collar B is a threaded flange for the sleeve E, which fits a recess in the face of the shaft bushing F. Packing is inserted at G and H. Drip flanges J project from the bushings and a duct leads to an outlet K in the pillow block for the escape of the oil from the bearing. Steam escaping along the shaft must pass over the sleeve A and then under the collar B before reaching the packing D, and by this time there will be sufficient condensation to prevent material leakage. Any leakage which does occur is pocketed in the space enclosed by the ring E, and serves to expel any oil dripping from the bearing at J through the duct and opening K, thus preventing the oil from accumulating and creeping along the shaft into the turbine.

The high and low-pressure shafts and casings are held rigidly only at the cool or exhaust end, so that they are free to expand against the direction in which the steam flows. This expansion is provided for also in the flexible

* No. XXIII. appeared November 25th.

couplings of the shafts. A stuffing-box of the form shown in Fig. 4 is used at each of the four places where the shaft enters the steam chambers.

The governor, shown in Fig. 5, is driven directly by the turbine shaft. At A is the governor spindle, with a sliding sleeve B connected to the valve mechanism. The casing C encloses the governor, and D is a cross spindle passing loosely through a hole in the governor spindle. The weights E slide on the cross spindle, and have collars

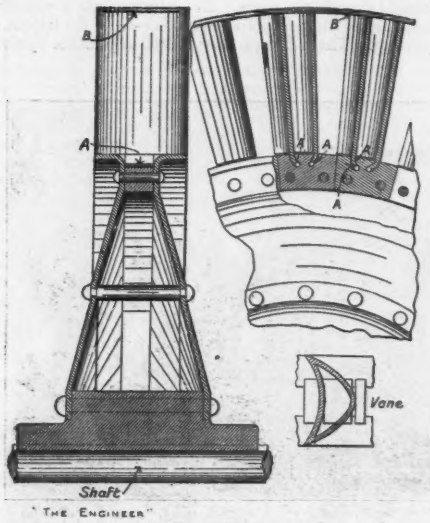


Fig. 3—HOLZWARTH TURBINE—REVOLVING DISC

F. The caps G on the ends of the cross spindle allow of adjusting the compression of the helical springs around this spindle, which oppose the centrifugal force tending to throw the weights outward. The two arms H are pivoted to the casing, and have rollers fitting the groove between the collars on the governor weights. These arms are pivoted on the shaft I, which has other arms J, carrying rollers fitted to a groove on the sliding sleeve B. At K is a collar attached to the governor spindle, and having

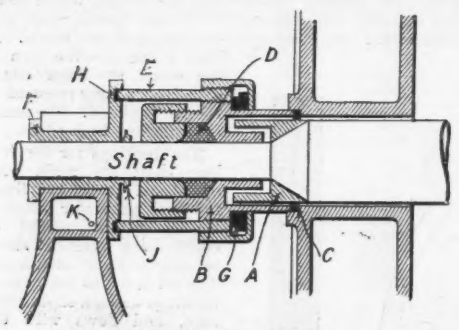


Fig. 4—TURBINE BEARING

ribs which mesh with other ribs on the sleeve B; steel balls, set in the grooves formed by the ribs, reduce the friction due to the sleeve sliding in the spindle. The weights have guide wings engaging with rollers L, carried by the casing C.

The regulating valve is not operated directly by the governor, for the reason that a direct-acting governor has not an equal resistance for all positions, and does not make the angular velocity of the turbine independent of the load. While the indirect action is more complicated, it is held to be justified where extremely close regulation is necessary, and when the moment of inertia of the rotating body is very large, as in a steam turbine. In this turbine the stem of the regulating valve is driven by means of bevel gears by a shaft supported in roller bearings. On this shaft is a friction wheel which can be moved across the face of a friction disc by a sleeve and bell-crank lever. The friction disc revolves continuously, and is keyed to a sliding shaft driven by a coupling from a hollow shaft, the latter being driven by worm gearing from the turbine shaft. The solid shaft is shifted by the governor sleeve, so that the friction wheel and disc only come into contact when the angular velocity changes. If this change is relatively great, the sleeve will draw the wheel towards the rim of the continuously revolving disc, and will quickly drive the stem of the regulating valve. In this way the intensity of action of the governor is varied as required. When the angular velocity falls below a certain percentage of the normal speed, the friction disc is drawn back by the governor; the regulating valve remains open and the regulating mechanism stops, although the shaft is still running. The governor shuts down the turbine when the speed exceeds 2½ per cent. above the normal, so that no auxiliary safety or emergency governor is necessary.

The main regulating valve is a double-seated balanced poppet valve. The steam is admitted from the inlet into a chamber at the centre of the valve, and openings at the top and bottom of this chamber contain the valve seats. Below the main valve, and forming a part of it, is the by-pass valve, which controls the steam supply to the by-pass nozzles in the low-pressure section of the turbine. This is also a double-beat poppet valve.

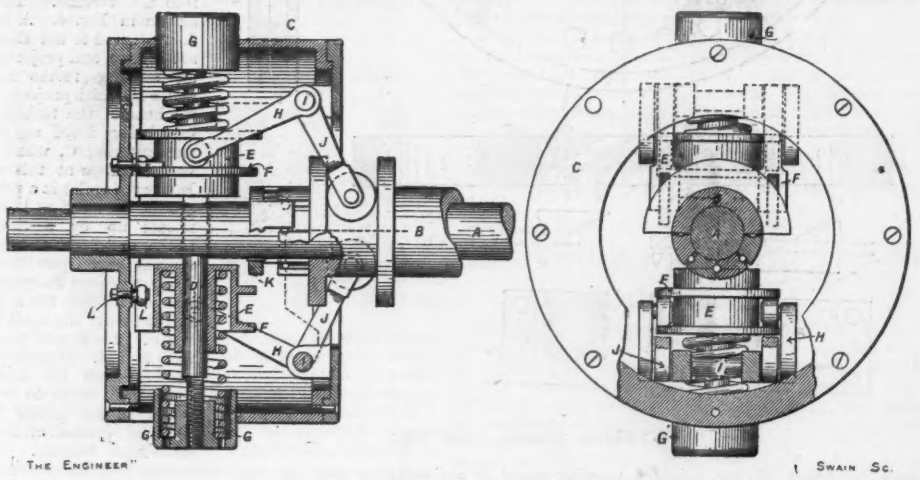


Fig. 5—TURBINE GOVERNOR

DESTRUCTION OF A MISSISSIPPI BRIDGE BY WIND.

THE probable wind pressure involved in the wreck of the High Bridge over the Mississippi River on Smith-avenue, St. Paul, formed the subject of a paper read by Mr. C. A. P. Turner before the American Society of Civil Engineers on December 7th. The bridge was built in 1887, and a reasonable factor of safety was allowed in the design for the maximum wind pressure required by the standard specification; but on August 20th last a portion of the viaduct was, presumably, destroyed by wind. The bridge is a deck structure of wrought iron, 2770ft. long, and runs north-west and south-east. The north-west portion is of the viaduct type, with riveted spans of 80ft. and plate girder tower spans of 40ft. Four-leg towers alternate with two-leg bents for supporting the girders. The portion of the viaduct over the river consists of four 250ft. pin-connected deck spans of the sub-divided Warren type, 30ft. deep and 22ft. from centre to centre of trusses. The floor beams are at 12ft. 6in. centres. The tower supporting the shore end of the south-east 250ft. span has a base of 55ft. transversely, and of 50ft. longitudinally, and a height of 129ft. from the top of the pier to the bottom chord of the truss. As these trusses were 30ft. deep, the roadway at this point was 160ft. above the pier, and about 180ft. above the water. From this tower towards the bluff there was one 170ft. pin span and two 60ft. plate girder spans. The bridge carries a 25ft. roadway and two side paths 8ft. broad each. The trusses were designed for a live load of 80 lb. for the roadway and the walks in the 250ft. spans, 90 lb. in the 170ft. span, and for all shorter spans 100 lb. per square foot. A pressure of 450 lb. per lineal foot was allowed for the wind pressure when designing the lateral bracing, two-thirds of which was assumed to act on the loaded upper chord. An efficient system of sway rods was also provided in the 250ft. span. The result of the accident was that a tower frame was overthrown and badly twisted, the 170ft. pin spans and the 250ft. pin span being also overthrown. From an examination of the broken structure, the author considers that the end of the 250ft. span resting on the two-leg bent was pushed off its support, and the wind acting on the loose girder—which has an area of from 10,000 to 11,000 square feet—and with the help of the 250ft. leverage, twisted the tower bent supporting the other end from its seat, the falling mass pulling the smaller girder spans down the hill. An examination of a two-leg bent similar to the one where the accident happened shows that the 250ft. span rested on a nest of eight rollers 2⅞in. diameter, with the usual spacing bars on the sides. The only method employed to prevent lateral movement of the rollers was a bar riveted to the cap on each side, and a recess in the shoe above from ¼in. to ⅝in. in depth. Provision had been made for a 1¼in. guard bolt each side of the shoe, but no bolts were found in place. On the windward side of the two-leg bent where the accident occurred only one roller was left, while on the lee side there were seven. It was also observed that the span was anchored by one bolt on the outside of the windward shoe. The author says there is no evidence of bolts ever having been in the other three holes. He states that an uplift on the windward side would be accompanied by a reversal of stress in the bottom chord, and with the slight resistance of the bolt, the shoe would be pulled from the cap and the rollers displaced, as appears to have been the case. It is shown by the calculations given in the paper that the computed uplifts—for the wind has been assumed to be blowing upward—is 15 per cent. greater than the reaction due to the weight, and even if allowance is made for some slight resistance due to the expansion connection of the stringers to the beam, the wind pressure was still 10 per cent. greater than necessary to have caused an accident. It is estimated that the laterals were not stressed more than 23,000 lb. to 25,000 lb. under the assumed forces. As the floor has an upward incline, it is thought that the angle of action of the wind may have been greater than that assumed, namely, 30 deg., and in that case the disaster would have been caused by a much less pressure than 27 lb. per square foot, which has been assumed for the calculations. Furthermore, there may be a considerable error in supposing that the pressure acted uniformly over the whole surface, and if it is assumed that the pressure was greater at the end of the structure, it is evident that the average pressure necessary to cause the wreck might be materially less than the 27 lb. used in the calculations.

LITERATURE.

The Metric Fallacy, by FREDERICK A. HALSEY, and the *Metric Failure in the Textile Industry*, by SAMUEL S. DALE. D. Van Nostrand Company, New York. 1904.

THE joint authors of this book have produced a volume which is the most complete indictment of the metric system that we have seen. From the preface we learn that it is an "outgrowth of a paper presented to the American Society of Mechanical Engineers in 1892." The second portion "is believed to be the first critical anti-metric analysis of the system from the standpoint of the textile industry that has been made." The book possesses the special merit that it has been written by men who understand commercial conditions. They do not argue against the metric system on abstract principles. They consider what it can do; what it would cost to introduce it, and how the price would be paid. In the main they take the same view as that which we have taken from the first, namely, that it would be the greatest possible mistake to tie down any manufacturer to a single system of measures and weights and capacities; and that, in short, mankind is so opposed to a single system that it has never yet been adopted or enforced in any country under the sun.

It must be clearly understood that this book does not deal particularly with the merits or demerits of the decimal system, which must not, indeed, be confounded with metric standards. It is very comprehensive; but the principal object of the authors is to show that the arguments of those who advocate the compulsory use of the metric system do not apply to ordinary commercial conditions either of buying or selling or making. Thus the metric advocate directs attention to what he terms a heterogeneous and confused mass of units in daily use in this and other English-speaking countries. But, as a matter of fact, the units which he criticises have no practical existence outside very narrow and strictly specialised circles. For the great mass of English-speaking people the units are very few and very simple. As units of length we have the inch, foot, yard, and mile. As units of capacity, the pint, quart, and gallon. As measures of weight, the ounce, pound, hundredweight, and ton. It is quite true that special trades use special units. Thus, for example, the brewer speaks of a "hogshead" or a "kilderkin," and the wine merchant of a "pipe," but no one but the brewer or the wine merchant concerns himself with these things. We see, therefore, that the introduction of the metric system would not only affect the mercantile operations of the general public, but of the trades concerned. For example, a "pipe" of port is a foreign not an English standard, and unless the Portuguese wine makers were compelled to sell by the litre, the English wine merchant would be compelled to make a calculation every time he dealt in port. The fundamental error in the whole matter is based on ignorance of what takes place in the countries which are supposed to have adopted the metric system. A considerable portion of the volume before us is occupied with a statement of the true trading position held by the foreigner. The State Department of Foreign Commerce at Washington has procured for the guidance of consuls and others a table of foreign non-metric units in continual use in different countries where the metric system is nominally legally enforced. From the list we find that there are more than 300 units in daily use, and the worst of the matter is that the same names are given to different quantities in different districts. Take for example the "pfund," or pound. The word has eight different meanings. Thus the pfund in Austria means 1·2347 lb. English; in Bremen its equivalent is 1·0991 lb.; in Frankfort it is 1·1141 lb., and so on. The ohm has nothing to do with the electrical unit of resistance; it is a measure, or, rather, six measures, of capacity, varying between 49·8197 gallons English in Berlin and 13·4459 gallons in Basle. So long as people buy and sell by such units it it useless to assert that the English-speaking people of the world are behind the age.

A favourite argument for the adoption of the metric system has been that because textile manufacturers have not adopted it their trade suffers. It will come as a surprise perhaps to those who argue in this way to learn that the metric system is not exclusively used by the foreigner in this class of manufacture. No more crushing attack on it has ever been made than that contained in Mr. Dale's contribution to the book before us:—"Cotton yarn is reckoned by the English hank and reel; this has been adopted by all spinners of nearly every country. The price is always given in the English pound." This is a translation from a German ready reckoner for textiles published in Barmen in 1901. The author tries to evolve symmetry from confusion. He gives a table of ten standards of length, nine of them "ells" and the tenth the Russian "archin." A "Bavarian ell has 34½in. or 84 cm.. A metre is equal to $41\frac{1}{10}$ Bavarian inches. One thread of single yarn per centimetre in a fabric 1 Bavarian ell wide and 54 Bavarian ells or 45 m. long gives a length of 3780 m., and at 60 grammes per 100 m. for No. 1 yarn English a weight of 2268 grammes." Again, in the same book: "The

usual twist is from 25 to 30 turns per English inch. The expression so-and-so many turns always means per English inch, and this is the universal practice in the trade. In order to determine the number of turns accurately, the number in a metre as indicated by a twist counter is divided by 40, as there are 40 inches in the metre." Here we have an attempt to secure a round number at the expense of accuracy. To quote once more: "All plans to dispense with the English hank of 840 yards have heretofore involved the changing of our reels and skeins. From a practical standpoint we do not regard this as possible. While theorists favour the adoption of the French system with 1000 m., I do not believe that its introduction is possible. The cost of changing our machinery and altering the yarn numbers offer insurmountable obstacles to the project. Furthermore, we do not believe that the introduction of the metric system would be of any advantage to the spinner." Let it be borne in mind that all this refers to a country in which the metric system is supposed to represent the only legal standard. It would take more space than we can spare to follow this line of argument. It must suffice to say that Mr. Dale reproduces facsimiles of page after page from the table books in use abroad, which bear out the statement that

> The evidence presented by Europe proves that a change of textile standards is a task of such difficulty as to be practically impossible even when worked by all the might of arbitrary and despotic power, and confirms beyond a doubt the belief that an attempt to change textile standards in a free country like the United States is simply impossible, and that partial success would create confusion instead of contributing to uniformity.

One of the most efficient arguments in the book is that urged by Mr. Halsey. If the metric system is partially adopted that will only add another set of units to those already in use. But judging by continental experience extending over about 110 years, it is quite impossible either to compel or induce any nation to adopt a single uniform system of units. It would be about as easy to compel all men and all women to wear uniforms, or to eat precisely the same food, or live in the same kind of house. Experience proves that although beer might be sold by the litre in shops, brewers would continue to use hogsheads and kilderkins in the trade. All this has not even a remote connection with the merits or demerits of the metric system. It is a psychological phenomenon, and must be dealt with accordingly.

Mr. Halsey has not a word to urge against the use of the metric system by the scientific man, the chemist, or the electrician. He explains in a way that is very novel the precise reason why an analytical chemist, for example, should regard the question from a standpoint quite different from that of the grocer. The chemist has to ascertain the weight of given quantities, the retail dealer has to ascertain a quantity equal to a known weight. Applying this to measurements, Mr. Halsey writes, "The scientific use of measurements consists in measuring existing things; the industrial use of measurements consists in making things of a required size." This is very neatly put. Again,

> The chemist places a substance in one pan and proceeds to balance it with his weights and rider. This is the exact opposite of the grocer's use of the scales. The grocer places his weight in one pan first and then proceeds to balance it with the required amount of material. The chemist finds the weight of a given mass of material; the grocer finds the mass of material which shall have a given weight. Because of this difference the grocer has but few weights. He deals with halves and quarters of a pound or ounce, and with no other fractions whatever. The chemist, on the contrary, must be prepared to deal with all possible fractions, and with the same degree of facility in all cases.

A prominent fact overlooked in the controversy is that, as a rule, the weights and measures of a country are survivals of the fittest. Useful changes are always adopted. Quantities which are not favoured are not used. For example, in our own country no one outside a very narrow circle has anything to do with troy weight. No landsman uses a cable, or a knot, or a fathom, as a unit of length; but these units are valued by sailors, because their mention establishes at once a mental concept which can have no existence for the landsman.

There are 231 large octavo pages in this book, and every page contains an argument against the compulsory adoption of the metric system in the United States. We do not believe that it is possible to write anything which can act as an efficient counterblast to this book. The case is simply overwhelming against a compulsory metric system. Even if it were conceded that the metric system was superlatively good, that would not suffice to secure its complete adoption. That it is well adapted to the language and purposes of scientific thought we freely concede. That it is desirable that all scientific men should use one system of units is highly desirable, even necessary, just as they have been driven to Greek and Latin for names. But to insist on the popular use of the metric method is as wise and as likely to succeed as an attempt to make every cottager call his vegetables and flowers by their Latin or Greek names.

Finally, we heartily recommend this book alike to the friends and the enemies of the metric system. The latter will find much to think about, and will, perhaps, realise the true nature of the task which they wish to perform. The former will find their hands strengthened, and, like ourselves, will rise from a perusal of the book confirmed in the conviction that the objection to the English system is based on ignorance of its true powers, and that it is about as well to attempt to limit the range of units in use by a nation as it would be to insist that a carpenter shall use only one set of tools, a physician one kind of remedy, or a railway one type of locomotive. The mistake lies not in advocating the metric system, but in not perceiving the nature of its limitations, and in attempting to extend it into an industrial field to which it is not suited.

BOOKS RECEIVED.

Locks and Builders' Hardware. By Henry R. Towne. London: Chapman and Hall, Limited. Price 3 dols.

How to Build a Petrol Motor. By James F. Gill. London: Dawbarn and Ward, Limited, 6, Farringdon-avenue, E.C. Price 6d.

THE ELECTRIFICATION OF THE METROPOLITAN RAILWAY.

No. V.*

IN the first four articles of this series which appeared in our issues of the 12th, 19th, and 26th February, and the 11th March of this year, we gave a detailed account of the work done in the electrification of the Metropolitan Railway. At the time those articles were appearing the power station at Neasden had no machinery in it at all. The boilers were being erected, and the machinery being slowly delivered, but nothing was completed. On Tuesday last, however, such has been the progress made in the meanwhile, the first electrically-propelled train, carrying public passengers, was run, with great success, from Baker-street to Uxbridge and back.

The chairman and directors of the Metropolitan Railway invited a large number of railway engineers and officials and others, first of all, to lunch with them, and afterwards to make this first public trip on the converted line. It will be remembered that the power station is to be equipped with steam, turbo-electric generators of 5000 horse-power each. Of these combined sets two are at present erected and at work, while the other two are in the course of being installed by the British Westinghouse and Manufacturing Company. Eventually, these four generating sets will work the traffic over the 27 miles of line which are to be operated electrically. The four sets will together have a capacity of 20,000 horse-power, with an overload capacity for short periods. When, however, this power shall, in the future, have become too small to deal with the increased traffic which is confidently looked forward to, it will be no difficult matter to extend the buildings so as to include additional machinery.

We have already dealt at length in the preceding articles with the generating station and the permanent way. It will therefore not be necessary to go into these matters in detail in the present instance. We may here repeat, however, that the alternators are designed to generate direct three-phase current at 11,000 volts. One of the combined sets is shown in Fig. 2 below. At this pressure the current is eventually to be transmitted through three-core armoured cables to nine sub-stations placed in different positions on the railway. The majority of these are erected and at work. In these sub-stations the high-tension current will have its pressure reduced by static transformers to 440 volts, and at this pressure it will be supplied to rotary converters, which, in their turn, will produce direct current at a pressure of from 550 to 600 volts. The direct current is then supplied to the lead and return conducting rails on the permanent way. Both of these rails are, it will be remembered, insulated from earth.

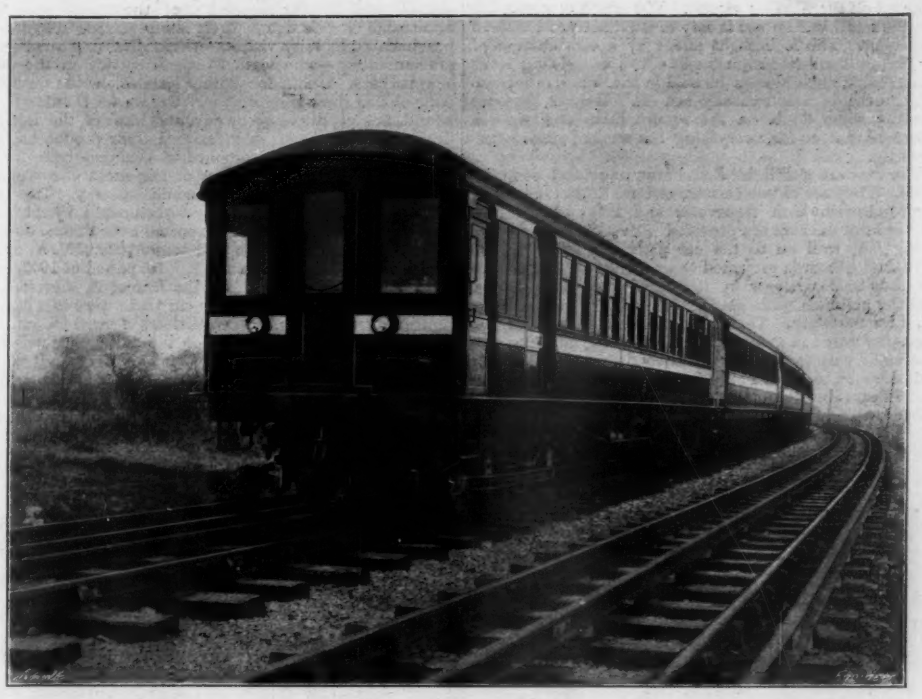


FIG. 1—ELECTRICAL TRAIN—METROPOLITAN RAILWAY

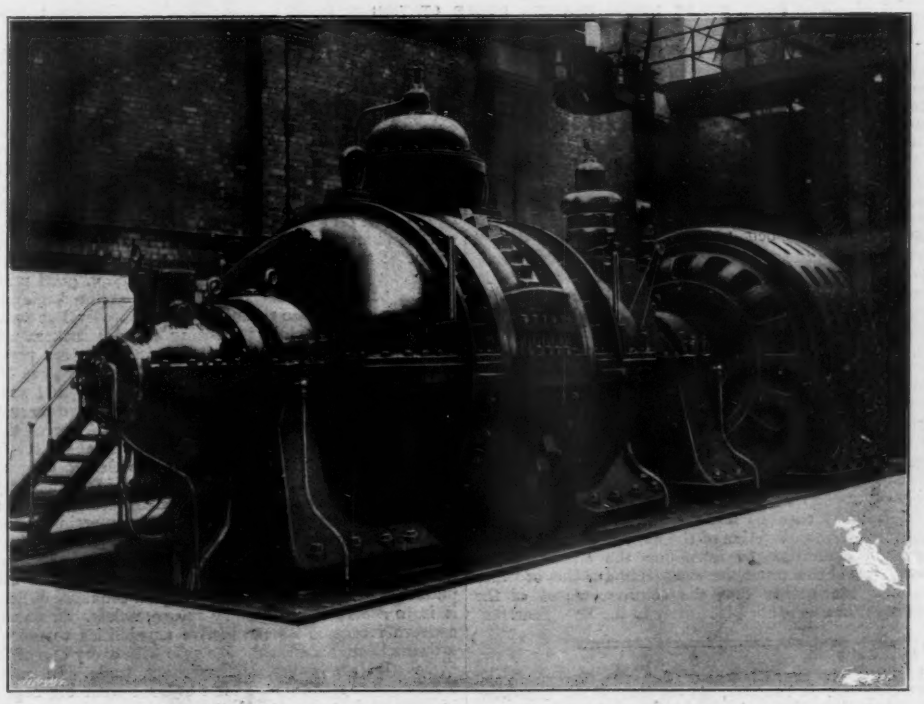


Fig. 2—5000-H.P. TURBO-ELECTRIC GENERATOR

The rolling stock which the Metropolitan Railway Company has had specially constructed for the electric service is similar in many respects to that employed on other electrically-driven lines. In our issue of the 12th February last we gave engravings showing the exterior and interior of one of the coaches. In Fig. 1, above, is shown a view of the train in which the opening trip was made on Tuesday last. No electric locomotives are used

* No. IV. appeared 11th March, 1904.

but there is a motor car at each end of the train. Each motor car runs on two bogies, and each axle is equipped with a motor. The weight on each axle is about 10 tons, and the motors are sufficiently powerful to slip the wheels. An acceleration of 3ft. per second per second will, we are informed, be possible, but it is anticipated that an acceleration of not more than 1¼ft. per second per second will be employed in ordinary working. The controlling mechanism is extremely ingenious, though at first sight somewhat complicated. No high-tension wires come into the driving cabin. The highest pressure used there is 14 volts, obtained from a secondary battery charged off the lighting circuit. The working controller is quite small, and its use is only to itself actuate the main controller. This is brought about by a combination of air pressure and electro-magnets. The controlling lever in the cabin must always be held in the hand, otherwise the current is automatically cut off. The air pressure used is some 80 lb. on the square inch, and we are informed that, so far, everything has worked most satisfactorily.

The cars are well lighted, and are roomy and comfortable. They are of two classes, and are 52½ft. long, being arranged with both transverse and longitudinal seats. The ends of the cars are provided with sliding doors, and swing gates lead on to the car platforms. We noticed that the footboards projected some inches on to the platforms so that accidents by falling between the carriage and the platform while getting into or out of the coaches is an impossibility. The superior class non-smoking cars are upholstered in green moquette. In the smoking cars leather is employed. All the second-class have buffalo hide covered seats, and only differ from the superior class cars in that the decorative work is less elaborate. Electrical heaters, fixed under the seats, are installed in every car. Every possible provision has been made to ensure full protection against fire. Sheet steel panels, asbestos and other non-inflammable materials have been introduced wherever possible or necessary. All the stock has been built at Birmingham and Manchester by the Metropolitan Amalgamated Railway Carriage and Wagon Company, Limited, under the immediate direction of the railway company's carriage and wagon superintendent.

We can offer nothing but congratulation to the company and to all concerned in connection with the trial trip, which we had the pleasure of accompanying. Everything went without a single hitch. Uxbridge was reached without a stop from Baker-street in just over thirty-three minutes. Whenever speed was called for it was forthcoming and there always appeared to be plenty of power in hand. Having regard to the fact that the special train had to be sandwiched in between the ordinary traffic, high speeds over long distances were not attempted. Forty miles an hour were, however, exceeded on several occasions.

We may add, in conclusion, that the organisation of all the work has been in the hands of Mr. A. C. Ellis, the general manager of the company, and that he has been assisted by Mr. Thomas Parker, the consulting electrical engineer, and Mr. C. Jones, who has been appointed chief electrical engineer. Mr. E. P. Seaton, the company's engineer, has had the direction of the line works, and Mr. A. Ingram, the carriage and wagon superintendent, has supervised the construction of the rolling stock. It is the company's intention to introduce the electric trains gradually, and to remove the steam trains as this becomes possible. We gather that the commencement of the electric service will take place early in the New Year.

GLASGOW UNIVERSITY ENGINEERING SOCIETY.—At a meeting of this Society held on Thursday, the 8th inst., at the University, Mr. Andrew Home Morton, Assoc. M.I.C.E., A.M.I.E.E., delivered a paper, entitled: "Some Notes on Sewage Plant." The paper dealt with the plant installed and employed in the treatment and purification by chemical precipitation of the sewage of Glasgow on the north side of the river. In view of a visit of the University Engineering Society to the Partick pumping station and the Dalmuir outfall works, both of which are very important parts of the western district sewage scheme, put into operation in May, 1904, the author described the plant and machinery at these places in detail. The plant at the eastern outfall works, Dalmarnock, was also described, chiefly to show the great value of the ten years' experience of working gained on these works, and utilised in designing the larger works and equipment of the western district sewage system. The paper was illustrated by lantern slides from photographs and plans of the works.

MOTOR CARS IN PARIS.

(By our Special Correspondent.)

No. I.

IN making our usual annual survey of the progress accomplished by the motor car industry, as judged by the vehicles exhibited at the Paris Show, we are first of all struck by the rapidly growing importance of this great automobile fair. It is, indeed, something more than a show or an Exhibition, for while the general public crowd, at times, by tens of thousands in the huge Grand Palais, attracted by the art displayed in the arrangement of stands, and by the pleasing effects obtained with innumerable electric lights, there is an incessant stream of provincial and foreign visitors—the English and Americans predominating—who come to spend money on the purchase of cars. Unlike most other Exhibitions the business done at this show is enormous. Orders for thousands of pounds are given out every day, and most of the leading firms seem to have sold forward their production for the coming year. The amount of business being done with foreign countries is one of the most encouraging features of the French automobile industry. The importance of this business may be estimated by the fact that the value of motor cars exported from France during the first ten months of the year was 60,839,000f., as compared with 43,849,000f. in the similar period of 1903, and with 26,537,000f. in 1902. On the face of it, therefore, it would appear as if the motor car trade were in a highly flourishing condition. Nevertheless, if we follow the fortunes of the industry through the entire year we shall find that this happy state of things is chequered by periods of deep depression, when the trade is suffering from all sorts of ills that are usually summed up in over-production and financial troubles. This difficult period usually begins with the end of August, when people have ceased purchasing touring cars, and lasts until the show; that is to say, for three full months. At that moment makers have filled their season's contracts, and must continue to manufacture to keep down working costs, with the result that a considerable number of cars are turned out during this period which can only be disposed of by sending them away to the English Colonies and foreign countries. So far as buyers nearer home are concerned, these cars lose something of their value owing to the fact that the new models will soon be on the market.

It can hardly be said that this question of over-production affects the leading firms who have a universal reputation, for the cars will always command a good price, and the output is usually sold forward at the beginning of the year. But the situation is undoubtedly less satisfactory for that rapidly increasing class of makers who find at the end of the season that their profits are partly swallowed up by the large number of cars that are left on their hands. It is here, also, that we can find some explanation of the financial troubles which have recently been hanging over the automobile industry. Seeing that the industry is of somewhat a precarious character for those whose position does not ensure their selling the whole of their production, it is evident that there is always a risk of the profit on the year's working being much less than would seem to be warranted by the margin between the cost of production and the selling price. When a firm's capital is small there is always enough to be made to pay a fair return in the case of vehicles that meet with public favour, but the larger the capital the more difficult it is to secure a satisfactory return, unless, of course, a concern increases its productive capabilities to meet a growing business. This is the case with every one of the firms who are doing a flourishing trade. In many instances companies have been created with big capital to build up a business, and some of them are now trying to raise further money to avoid difficulty. No branch of the engineering industry is more deceptive, or is calculated to give rise to more disappointment, than the manufacture of motor cars. At the same time, there is nothing capable of giving a bigger return upon capital than an automobile concern, subject to its first of all building up a sound reputation, and extending its manufacturing facilities without calling in any considerable outside financial support.

This somewhat uncertain character of the motor car industry must continue so long as makers are obliged to put new models on the market every year. The new types of car depreciates the old ones, or, at all events, render their sale more difficult, and thus the Paris Show means that an enormous amount of capital, represented by a part value of the unsold cars, must be written off for depreciation. It is clear, therefore, that makers have every interest in seeing the cars reduced to a settled type. They will not only save the depreciation, but will avoid the expense of developing new models, which represents a no small item in working costs. Nevertheless, the fact that the motor car is not yet perfect induces the public to look for improvements, and the introduction of new features is a recommendation for the cars. Despite the advantage which makers have from a business point of view to adopt what may be regarded as improvements, it is noticeable at the show that several of the big firms are exhibiting cars which are almost identical with their previous types. Even such a firm as Panhard and Levassor, who can hardly be accused of neglecting the smallest chance of improving their vehicles, are showing the same types of cars as last year, with the exception of a 50 h.p. chassis in which have been incorporated some of the features of the racing cars that have been running during the past season. Makers generally are of the opinion that, with the huge factories now in operation, they are not justified in changing patterns which would upset the workshop routine, where each man has been accustomed to a special class of work, unless such change represents a real improvement; and therefore, as in the case of Panhard, one type of car only is introduced with the new features, which will have to receive the sanction of users before they are adopted on the other vehicles. We have, therefore, arrived at a point where further progress in motor car design must necessarily be slow, and to this extent we seem to be reaching a period when the motor vehicle will settle down to uniform patterns. There is, of course, plenty of novelty at the show, for the fertility of the engineer in automobile construction is inexhaustible, but seeing how the many apparently promising inventions of the past have had to give way to simple refinement of standard mechanism, it has become almost hopeless to expect that we shall see any further radical changes in motor car design unless something more can be done with the internal combustion engine.

We are no longer able to convey anything of interest in automobile engineering practice by giving a detailed description of the leading makes of cars. A description of one taken at random would apply equally to others, so far as the general lines are concerned, and it is only when we come to look into details that we can discover any appreciable difference in design. It is solely in this critical examination of a car, to discover little points that may or may not be improvements, that lies the interest of the Paris Show. Most of those firms who have regarded it as imperative in the past to break away from standard designs are now coming back to them again, and very little is heard of inventions which, at previous shows, gave promise of influencing the construction of motor cars. For cars of more than 16 horse-power the four-cylinder engine has become paramount. There seemed to be every room for believing, a year ago, that the three or six-cylinder engines would become a prominent feature, the former especially being regarded as certain to replace the two-cylinder motor, but makers and users have come to the conclusion that if it be found necessary to employ three-cylinders for the sake of getting a constant turning force there is no reason why another cylinder should not be added to obtain still better results. The automobilist who has driven a four-cylinder engine will never return to a two or three-cylinder motor. The bogey of complication has long disappeared with the simplifying of the engine and an improvement of the ignition, while the facilities for locating ignition troubles, and remedying them, have made the four-cylinder engine just as convenient to handle as the two-cylinder. We will go more fully into this question when we come to deal with the developments of the internal combustion engine. The problem of operating the valves has been solved by common practice, for we have not yet seen a single engine in the show in which the induction valves are automatic. De Dietrich et Cie. were one of the last to hold out for the automatic inlet valve, but in their new cars even they have adopted valves mechanically operated on the top of the cylinder breech by stems and tappets. This practice, introduced by the Mercédès, was for some time copied by

Fig. 3—BOILER HOUSE—NEASDEN POWER STATION

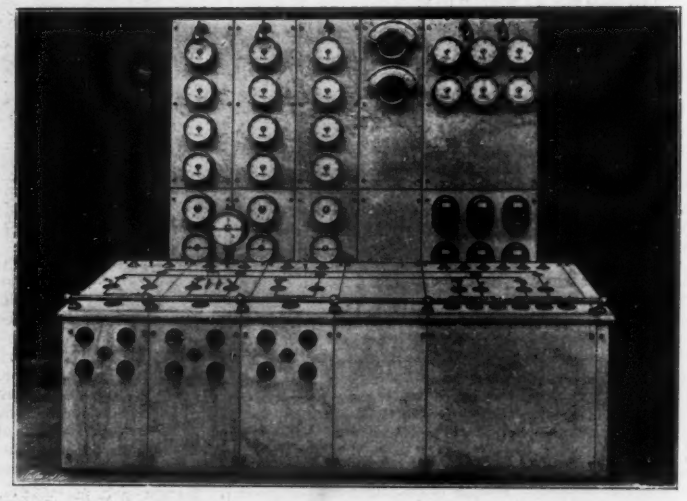


Fig. 4—CONTROL BOARD—NEASDEN POWER STATION

several of the French makers. Others had the valves on one side actuated by one cam shaft, under the impression that by placing the valve chambers on each side of the cylinder the spreading of the gases in the larger space was not favourable to high compressions. Although the theory was plausible it has not carried much weight, and there is once more a growing tendency to build engines with the valve chambers on each side of the cylinder.

Having settled down to one recognised type—with four-cylinder engine, sliding variable speed gear, and propeller or chain drive—makers are endeavouring to simplify the mechanism and increase the efficiency of the motor and transmissions. One of the principal drawbacks is the accumulator with coil and trembler. The possible troubles from this source are legion. The battery may run down at an inconvenient moment. Good coils are not always easily obtainable. The trembler may need frequent adjustment. But with all its faults the accumulator and coil constitute the best system of ignition, and when running with an advance of ignition, the engine develops appreciably more power with the accumulator and coil than with the magneto. Nevertheless, the advantage of having an electrical generating machine is so considerable that the magneto is coming into almost general employment. For the moment its somewhat delicate construction rather deters car users from relying entirely upon this apparatus, although experience has shown that there is little trouble to be feared from any derangement of the magneto, and until automobilists become more familiar with the magneto machine it is customary to fit it in conjunction with the accumulator and coil, this latter as a reserve. The Cie. de l'Industrie Electrique et Mécanique, of Geneva, even goes so far as to supply three ignitions. On the Simms-Bosch magneto shaft is geared a Comète magneto machine, which can be used either with the low-tension magneto or independently in the event of the latter failing, or it may be employed for recharging a small battery of accumulators which is available for the head-lights or for motor ignition. It is evident that all this complication will disappear with an improvement in the magneto, and so much has already been done in the way of giving it a greater reliability and efficiency that there is every probability of the magneto entirely supplanting the accumulator and coil in the coming year. It is by no means unlikely that even the magneto will find competition in some of the new ignition devices, for at the Show the Société Industrielle des Téléphones is exhibiting a small dynamo and sparking plug, coil wound, which gives sparks so hot that they were unaffected by oil dropping on the platinum points. There is no doubt that the ignition problem has now been entirely solved, and that with the dynamo and magneto machine will disappear one of the principal sources of trouble, at the same time that this more efficient firing of the gases will assist in giving the much desired flexibility to the engine.

This general review of the new vehicles will show that there is little hope of any further important changes in French car design. While in England makers still think that there is plenty of room for originality, and are trying all sorts of mechanical expedients for increasing the efficiency of engines and transmissions, the French manufacturer is regarding any new invention with perhaps an exaggerated critical attitude. No one knows better than he that the petrol car has many serious shortcomings, and in the way of clutches, for instance, he would like to see a considerable improvement, but the industry has developed so enormously, and is organised upon such a vast scale, that he does not want to carry out any important changes to his cars unless they are forced upon him. The thing he has to strive against is competition. Every year new firms are coming into the industry. There is not much opening now for small people to start upon the manufacture of motor vehicles, unless they lay themselves out specially for light cars, and the most important development of the industry is the activity with which such great engineering firms as Creusot, Hotchkiss, Westinghouse, and Delaunay-Belleville are taking up the construction of motor vehicles. It is no longer a question of each firm designing cars according to their own theories. All their theories have been reduced to a common practice, and new makers who have facilities for building cars can turn them out as well as the old-established firms. For the same reason, this settling down to standard patterns to enable makers to monopolise foreign trade has had the effect of raising up an increasingly formidable foreing competition. Some of the cars exhibited by Italian, Belgian, and German firms are constructed upon thoroughly up-to-date lines, and in workmanship and finish compare favourably with the French vehicles. The Mercédès design has become the standard for imitation, and differs only in matters of detail. The well-known Fiat cars of the Fabrica Italiana di Automobili, of Turin, have already secured a universal reputation. The Fabrica di Automobili "Florentia" are constructing vehicles under licence from Rochet-Schneider, whose cars were originally a copy of the Mercédès. Another excellent car on the same lines is that shown by Isotta, Fraschini et Cie., of Milan. In Belgium the Pipe cars are acquiring a considerable reputation, while in Germany the number of makers is increasing so rapidly that this country is likely before long to become a very large producer of cars. It can, therefore, easily be imagined how this growing home and foreign competition should have completely changed the conditions of the French industry during the past year or two. Having secured a long lead on their foreign rivals, they are endeavouring to maintain this position by turning out cars in the largest possible numbers, for which purpose some of them are considerably extending their works. One factory will shortly be producing 1800 large cars a year. There are at least half a dozen others which turn out not less than a thousand. Under these circumstances the unwillingness of French makers to design entirely new models every year can be understood. They are trying to perfect the motor car by simplifying the mechanism and carrying out little improvements in detail, and how far they have succeeded in producing satisfactory and reliable cars will be seen in future articles.

POWER DEVELOPMENT AT NIAGARA.

DURING the summer the Ontario Power Company made considerable progress with its project to develop a portion of the energy of the Horseshoe Fall of Niagara. The scene of this company's operations is in Victoria Park, on the Canadian side of the river. Its plan is to take water above the upper rapids at a quiet portion of the river, and allow it to flow through two forebays, and then to and through three steel flumes having an interior diameter of about 18ft. These flumes will convey the water for more than a mile through Victoria Park, emptying it into a spillway, from which it will flow into penstocks that will conduct it to a power-house which will be situated at the water's edge in the gorge, only a short distance below the famous Horseshoe Fall. Ultimately, as the great project nears completion, there will be three of the great steel flumes extending through the park lands, each being intended to supply a section of the power-house and its installation.

The power developed in the station at the water's edge will pass over cables to a transformer house and distributing station built on property owned by the company at the top of the bluff in the rear of Victoria Park. In and from this station all the power will be controlled and distributed. Nearly 12,000 cubic feet of water per second will be diverted from the upper river, and this will be utilised in the development of between 150,000 and 200,000 horse-power, as demand makes it necessary and advisable. In a general way, the development of the Ontario Power Company will be somewhat similar to the development of the Niagara Falls Hydraulic Power and Manufacturing Company on the New York side, one of the differences being that the Ontario Power Company will conduct its water supply from the upper river through steel tubes, while the Niagara Falls Hydraulic Power and Manufacturing Company uses an open surface canal However, on the Canadian side, where the water is to be carried through a pleasure ground like that of Victoria Park, it has been deemed advisable to conceal the water-carrying device, and for this reason the great steel flumes will be

18-FOOT FLUME PIPE

covered over to make their route conform to the general scenic beauty of the park.

Comparing it with the developments of the other power companies at Niagara, there is no more interesting feature of the Ontario Power Company's work than the first big steel flume that will carry the water supply over 6000ft. This flume is believed to be the largest used for this purpose in the world. Three of the other power companies of Niagara have excavated or are building large tunnels to carry off the waste water from the turbines, but in this case the expenditure is made on a flume to provide a water supply, the water, after it passes the turbines in the power station at the water's edge in the gorge, flowing a few feet to the lower river close by. The big steel flume extends from a point above the Dufferin Islands to below the old Table Rock house, and there its water, the supply of which will be nearly 4000 cubic feet per second, will pour into a forebay, and then flow into six penstocks 9ft. in diameter and two penstocks about 30in. in diameter. The larger of the penstocks will carry the water supply for the turbines, while the smaller penstocks will supply the turbines connected with the exciters. As each 9ft. penstock approaches the turbines it will divide into two branches, each branch supplying one of the twin turbines that will operate the generators. Horizontal wheels, direct connected to the generators, will be used, the unit of development to be 10,000 horse-power.

In passing from the forebay at the top of the cliff to the power station at the water's edge, the penstocks will go through shafts and tunnels, and will thus be concealed from view of Niagara sightseers. The point of operations is right close by the falls, and every feature about the power-house is open to full view, unless such efforts at concealment are made. In this way, the industrial feature will but slightly mar the natural surroundings of the waterfall. This method of placing the penstocks is quite unlike the plan of the Niagara Falls Hydraulic Power and Manufacturing Company, where the penstocks stand out from the cliff in column form. This latter plant, however, is not so close by the falls.

While the complete installation of the Ontario Power Company will consist of eighteen generators, only three will at first be installed. Each machine will be expected to develop 10,000 horse-power, three-phase, 25-cycle, 12,000 volts, when making 187 revolutions per minute. The controlling apparatus for these generators will be, as stated, in the station on top of the bluff back of Victoria Park, the distance from the power-house proper being nearly 600ft. and the height about 250ft. The exciters and their turbines will be installed on a gallery in the power-house.

Under the natural conditions which have heretofore existed, there has always been much trouble with the ice on the Canadian side of the Horseshoe. This has been observed in connection with the operation of the municipal water plant, and also in connection with the power station of the Niagara Falls Park and River Railway. For this reason, all the power companies now developing power on the Canadian side are taking great precautions to avoid this line of interference. The Ontario Power Company is providing two forebays, the outer of which will have an extent of about eight acres, and the inner an extent of about two acres. These forebays will divert far more water than will be required to supply the steel flumes of the completed installation. Where the water enters the upper forebay there will be an ice fender, while at the lower end of the upper forebay there will be a screen house. At the lower end of the inner forebay will be placed the valve or gate house, and at this point the water will be allowed to flow into the steel flumes, the centres of which will be nearly 20ft. below the low-water level of the forebay. Gates will control the flow of water into the flumes. The forebays are so planned that cross-currents are expected to carry the ice away from in front of the protectors. It is expected that power from the Ontario Power Company's station will be supplied some time towards the latter part of next year. The first steel flume is practically completed, and considerable work has been done on the power-house site. In order to facilitate operations below the cliff, the Park Commissioners permitted the company to break a roadway along the *débris* slope from a point near the old Clifton House, and on this tracks have been laid. Messrs. P. N. and L. L. Nunn are the engineers in charge of the work. On page 598 will be found several views showing different parts of this under way.

OBITUARY.

MR. EDMUND HUNT, lately of the firm of Edmund Hunt and Co., chartered patent agents, of Glasgow, died at Whitehall, Bothwell, N.B., on the 2nd inst., in his seventy-sixth year. He was a son of Mr. Richard Thomas Hunt, surgeon, of Manchester—one of the founders of the British Medical Association—and was born at Manchester on the 22nd of January, 1829. He was educated at the grammar school, Manchester, and, after leaving school, spent some years in Bahia, Brazil. Upon his return to this country he entered a patent agency in Glasgow, leaving there in 1857 to start the business which is still carried on. He was one of the original members of the Institute of Engineers and Shipbuilders in Scotland, of which he was the first secretary, holding office for seven years, and of which he was for three sessions a member of council. He was also a member of the Royal Philosophical Society of Glasgow, and of some others. Mr. Hunt was greatly interested in colour vision, and spoke before various societies upon the subject, also publishing a book on the subject in 1897. He was of mathematical bent, and made a deep study of the gyroscope. His mathematical studies led him into friendship with the late Professor Rankine and Sir Henry Bessemer, and to a large aquaintance amongst that older and Olympic generation of engineers and mathematicians which had its home in Glasgow in the fifties. His great experience as a patent agent, and knowledge of patent law, made him greatly in demand as an expert witness, and he figured in many of the most notable patent cases. He retired from business some four years ago, leaving it to the management of Mr. D. M. Ferguson—who had been associated with him for thirty years—and of Mr. Wilfred Hunt, his son. He is survived by three daughters, and three sons.

WE regret to have to announce the death of Mr. Joseph Nasmith, of Manchester, in his fifty-fifth year. The deceased gentleman was a member of the Inst. of Mechanical Engineers, and a past president of the Manchester Association of Engineers, of which body he was also a trustee. He was for a considerable period editor of a textile paper, but latterly he had been identified chiefly with a large firm of gas meter manufacturers. Mr. Nasmith was never afraid of work, and for some time devoted much of his time to local public affairs. His early death is a source of much regret amongst a wide circle of friends. At the annual meeting of the Manchester Association of Engineers a resolution was moved by Mr. Ashbury expressing the deepest regret for Mr. Nasmith's death, and recognising the valuable services he had rendered to the Association during the past twenty-four years of his membership, and it was further decided that a resolution of condolence be sent to his widow and family.

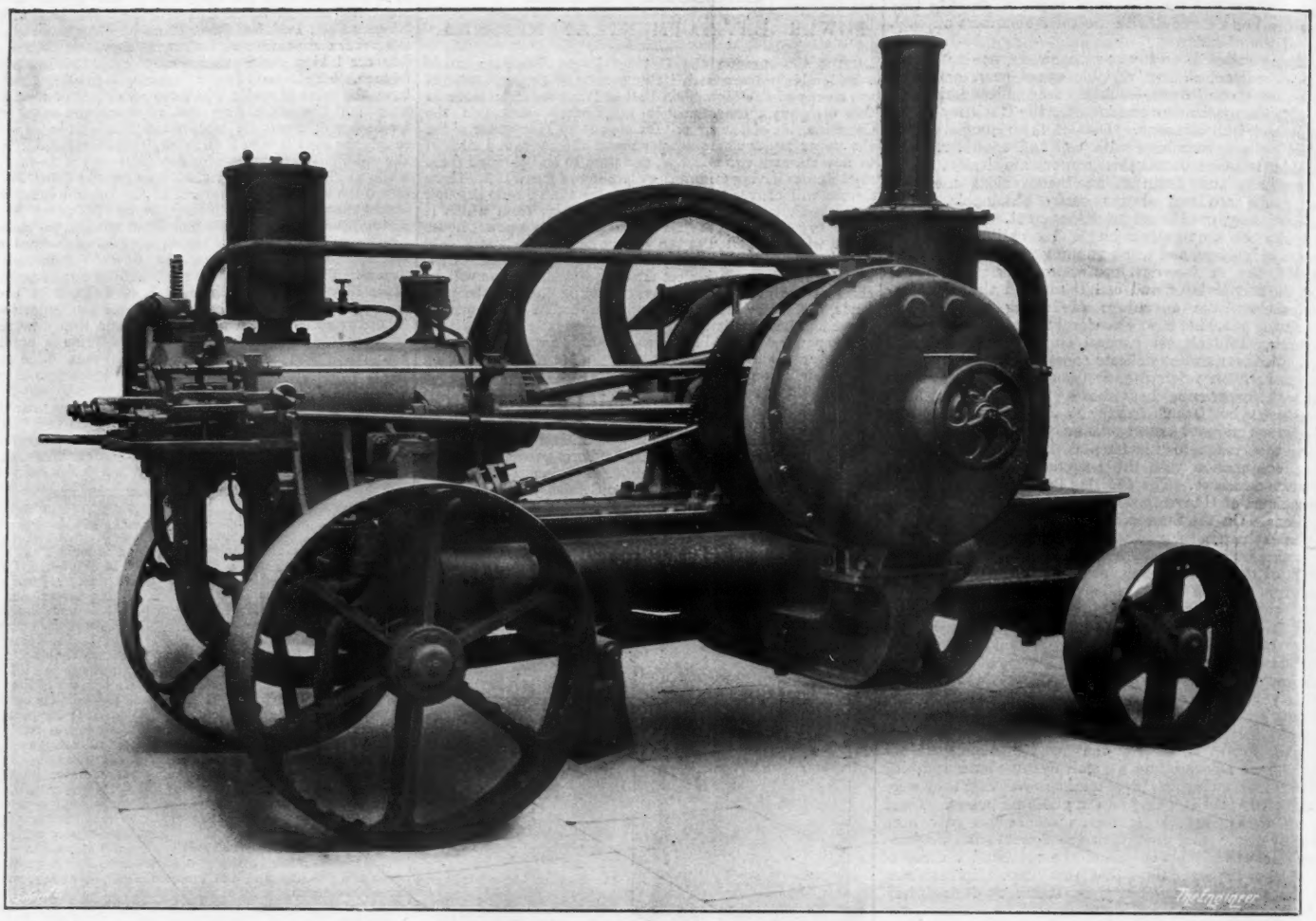
THE death took place a few days ago of Mr. William Ashmore, of Stockton, who has for more than half a century been connected with the engineering industry of Teesside. He was one of the founders of the firm of Ashmore and While, whose business was taken over more than twenty years ago by Ashmore, Benson, Pease, and Co., Limited.

A NARROW ESCAPE.—An accident, which might have been similar in consequences to that of Montparnasse (Paris), recently occurred at Venice. The express from Milan to Venice, drawn by one of the new four-cylinder compounds, having the cab at the front end, ran into the terminal station at high speed, demolished the fixed buffers, and leapt over the low end platform into the left-luggage office beyond, bursting through a heavy intervening wall. The accident was due to the Westinghouse brake acting only upon two of the coaches, the reason of which appears to have been that the negligence of an employé in forgetting, after shunting in the previous station of Mestre, to couple up the train-pipe. The main hall of Venice station is lower than the permanent way, the platforms being reached by a ramp; and, by reason of the great length of the trains, the engines usually run right up to the stops at a speed which would scare station-masters in France—where the rules are very different. It is probably due to the comparative ease with which the engine passed through the obstructions that the shock was not greater, only five persons being wounded. A few feet beyond the engine would have gone into the canal.

IRON AND STEEL IN THE UNITED STATES.—James M. Swank, general manager of the American Iron and Steel Association, has issued some interesting statistics of the production of iron and steel in the United States during 1903. The gross production of pig iron was 18,658,777 tons, and the consumption is 18,039,909 tons, compared with 18,436,870 tons in 1902, 16,232,446 tons in 1901, and 13,177,409 tons in 1900, so that the prosperity of the country was not so bad as most people imagined. There was a falling off in steel production, the output of Bessemer ingots being 8,592,829, compared with 9,138,363 in 1902, and an output of 5,829,911 tons of open-hearth steel against 5,687,729 tons in 1902. More than half of this steel was produced in Pennsylvania and the bulk of Pennsylvania's product in Pittsburg. The high-water mark of rail production was reached in 1903, with an output of 2,946,756 tons, compared with 2,935,392 tons in 1902. Of this Pennsylvania produced 1,186,284 to 1,760,472 tons manufactured in all of the other States. Of a total of 1,095,813 tons of structural material Pennsylvania produced 1,004,375 tons, compared with 1,178,760 in 1902, the total for 1902 being 1,300,326 tons. In other words Pennsylvania produced 91 per cent. of the total in 1903 and 90 per cent. in 1902.

PORTABLE OIL ENGINE

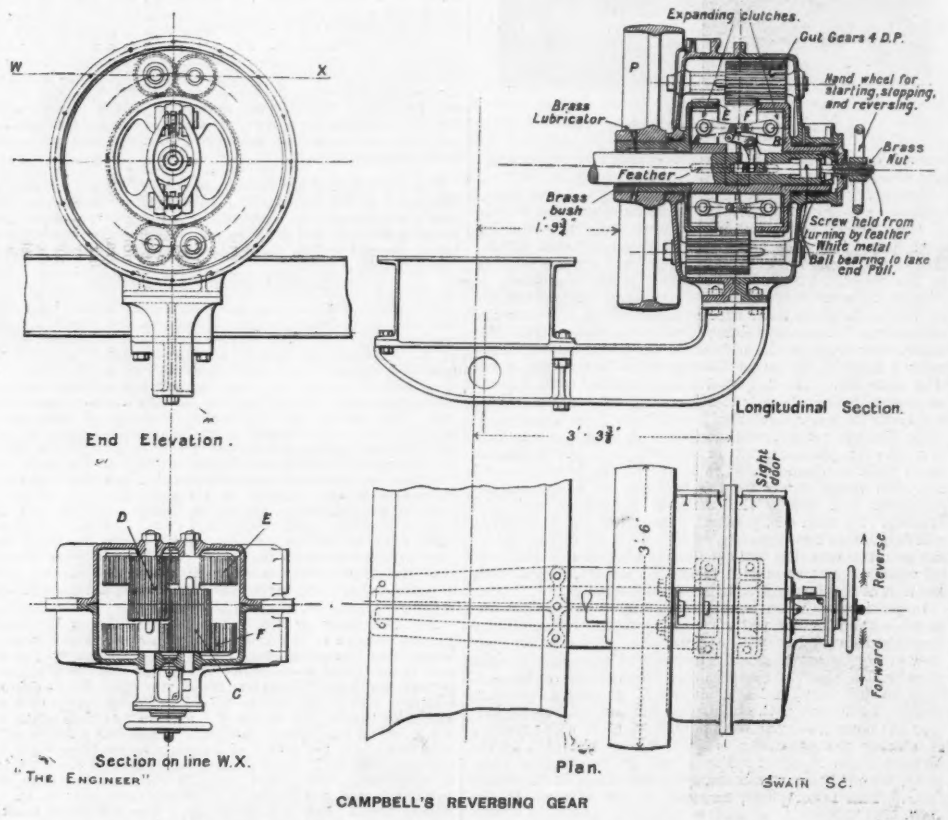
CAMPBELL GAS ENGINE COMPANY, LIMITED, HALIFAX, ENGINEERS



PORTABLE OIL ENGINE WITH REVERSING GEAR.

THE accompanying illustrations represent a portable oil engine recently constructed by the Campbell Gas Engine Company, Limited, of Halifax. The idea which the makers had in mind when designing this plant was that it should be capable of moving over heavy and difficult country where roads are practically non-existent. It is for this reason that the carrying wheels have been made broad in the face and of large diameter. They, moreover, are arranged so that they "track" with one another. Brakes are fitted to both back wheels, and, in addition, slippers are supplied for both these wheels.

The cylinder of the engine is mounted upon a steel truck composed of two steel girders plated over the top. To the underside of the girders are riveted axle-plates, to which the axles are bolted. In the interior of the truck is fitted an independent water tank of 50 gallons capacity. The engine cylinder is bolted to the truck and stayed by tie-rods between it and the crank pedestals. The cooling water is circulated by a pump, and after passing through the cylinder jacket it is delivered to the water cooler. In descending through this apparatus the water is met by a current of air passing upwards, and in this way the temperature is, we are informed, reduced from about 140 deg. Fah. to about 95 deg. Fah.



CAMPBELL'S REVERSING GEAR

During the last five years or so the vaporising arrangements in the Campbell oil engine have been considerably modified and improved. Five years ago it was practically impossible to use higher compressions than from, say, 45 lb. to 50 lb. on the square inch, owing to difficulties caused by pre-ignition. These difficulties have been largely overcome by the injection of water along with the oil into the combustion chamber and vaporiser. In the Campbell oil engine the water is not actually injected, in the strict sense of the word, but is drawn into the cylinder from the water-jacket. A special valve is fitted in the combustion chamber, and on the outstroke of the piston the water is drawn through this valve into the cylinder at the same time as the combustible mixture is drawn through the vaporiser into the cylinder. The water is vaporised by the heat of the combustion chamber and of the compression.

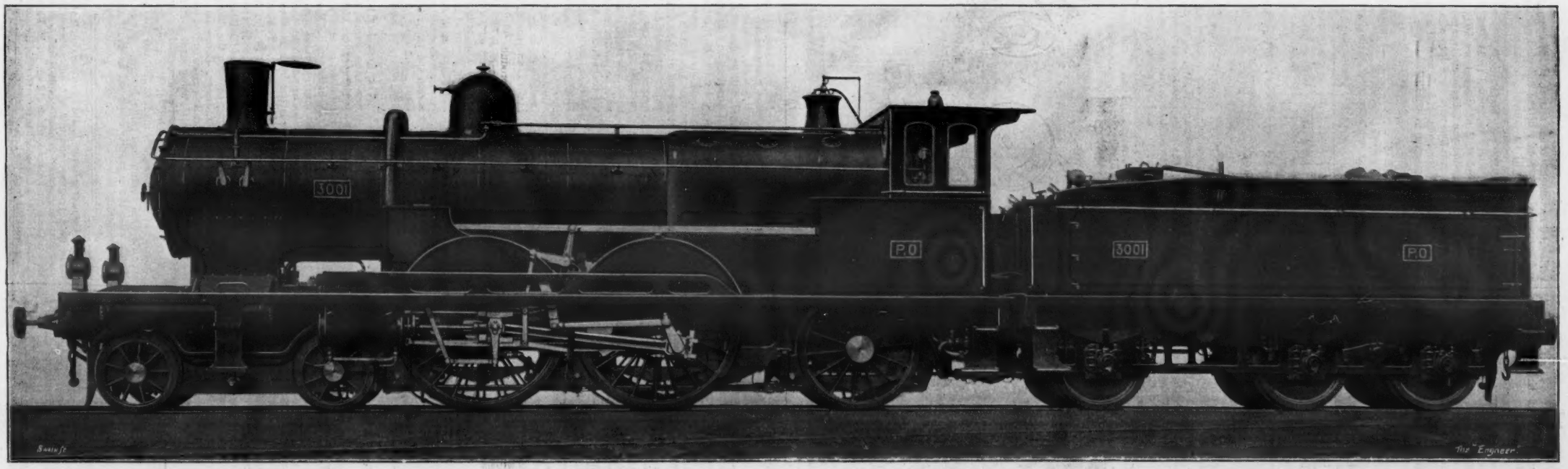
As a result, compressions of some 70 lb. to 80 lb. are obtained, and as a consequence of this there is a reduction in the quantity of oil necessary to produce a given power. In some cases this is as much as 25 per cent. The actual test figures of the portable oil engine shown in our engravings, which is of 25 brake horse-power, were ·64 pint of Rocklight oil per brake horse-power per hour. Another result of the higher compression has been that higher flash-point oils can now be used than was formerly the case. These oils are, of course, cheaper in price than the lighter and lower-flash brands of lamp oils. The same methods have, with certain modifications, been adopted by the Campbell Company for vaporising and burning crude oils.

In the particular engine which we illustrate a reversing gear has been applied to the crank shaft. This has been necessary because the engine is destined to be employed for oil-well drilling where the boring tool has to be driven in different directions for boring and withdrawing. The action of the reversing gear will be readily understood from the engraving. As shown, it is in the stationary position. By turning the hand wheel in a left-handed direction, as indicated, the four screws of the clutches A and B are caused to turn. They all move together, since they are connected and moved by the bell-crank lever. This action causes the clutch A to engage with the spur-wheel E, while the clutch B remains free. The pulley, which is keyed to the boss of the wheel E, then revolves with the engine shaft. For reversing the hand wheel is turned as shown, this action causing the clutch B to engage the wheel F. Then, by means of the pinions C and D, the wheel E, and with it the pulley P, are made to revolve in a direction opposite to that of the pulley P.

IT is decided to lay a second pair of rails on the Trans-Siberian, and a sum of 10 million roubles has been entered in the Budget for preparatory works. The working, for a length of 600 kiloms. (= 373 miles) of the railway for Oran towards the south of Algeria has given such encouraging results that a second train is now run daily between Aïn-Sefra and Beni-Ounif. From this latter place, the present terminus, the line has been pushed forward to Bechar a distance of 108 kiloms (= 67 miles).

PARIS-ORLEANS RAILWAY—FOUR-CYLINDER COMPOUND LOCOMOTIVE

SOCIETE ALSACIENNE DE CONSTRUCTIONS MECANIQUES, BELFORT, ENGINEERS



FOUR-CYLINDER COMPOUND LOCOMOTIVE, PARIS-ORLEANS RAILWAY.

THE illustration given above shows the four-cylinder compound locomotive for the Paris-Orleans Railway, which was fully described in our issue of June 3rd of this year. It will be unnecessary in the present instance to recapitulate the whole description, but the following main dimensions will be found interesting. The length over all is 11·975 m., and the weight is 71 tons 14 cwt. 3 lb. The diameter of the high-pressure cylinder is 1ft. 2·7in.. and that of the low-pressure 1ft. 11·62in., with a piston stroke of 2ft. 1·19in. The engine is fitted with Walschaerts' valve gear, the general arrangement being the same as on the de Glehn compound engines. The boiler is of the Belpaire type, and works at a pressure of 228 lb. per square inch. Its diameter is 4ft. 11·56in., and the plates are ·72in. thick. The grate area is 33·37 square feet; there are 139 tubes 2·75in. in diameter. The heating surface of the tubes is 2402·91 square feet, and of the fire-box 174·05 square feet, making a total of 2576·96 square feet.

CANADA'S NEW RAILWAY.

IN the session of the Dominion Parliament, commencing 11th January, financial arrangements will be submitted enabling the Government to proceed with the construction of the eastern division of the National Transcontinental Railway, to be leased to the Grand Trunk Pacific Company when completed. This undertaking will call for an average yearly expenditure of 10,000,000 dols., or £2,000,000, for the next seven years, on the main line from Winnipeg to Moncton. The branch lines will be constructed by the company or acquired by purchase or lease of existing railways; the obligations so far assumed by the Dominion Government relate to the main line only.

The work is to be carried out by a Board of four Commissioners appointed by the Government, with headquarters at Ottawa. The Act of last session stipulates that the work shall be commenced, "as nearly as may be simultaneously," at Moncton, Quebec, at the points of junction of the North Bay branch, and at Winnipeg; but it is understood that the primary object will be to give a through connection between Winnipeg and the proposed shipping depôt on the shore of Lake Superior. This will be effected by building the main line eastwardly from Winnipeg to Lake Seul, a distance of about 230 miles, connecting at that point with a branch line of 220 miles which the company will construct from the Lake Superior terminal. This section can probably be completed within three years, and will then give a third easterly outlet for the surplus products of the North-West, in competition with the existing lines of the Canadian Pacific and the Canadian Northern. The new route will be a few miles longer than the rival lines, but the gradients will permit the haulage of full train loads.

The next section will be commenced from a point near Lake Abitibi, on the boundary line between the provinces of Ontario and Quebec, the proposed terminal of the Temiscamingue and Northern Railway, which will probably be completed early next season. This is a line in course of construction by the provincial Government of Ontario for the purpose of opening up the lumber country and mining region lying north-west from the Ottawa Valley. From the Abitibi Junction the Trans-continental Railway will be pushed forward westwardly in the direction of Lake Seul to meet the easterly extension of the Winnipeg section. When this connection is made, which possibly may be within four years, the Temiscamingue Railway will be the connecting link between the Winnipeg Line and the Grand Trunk system of railways in Ontario and Quebec *vid* North Bay, available for through traffic from Winnipeg to Toronto, Montreal, Portland, and Boston.

The main purpose, however, of the new Trans-continental scheme is to provide a direct highway by the shortest possible route through the undeveloped northern territory from the wheatfields of Manitoba and the grazing lands of the North-west to the Canadian winter ports, Halifax and St. John. To this end, it is the declared policy of the Government that the easterly sections shall be carried forward to completion concurrently with the work in the West, so that the through line shall be made available at the earliest date practicable for so vast an undertaking. To the definite assurances given on this point is due the triumph of the Government in the recent General Election, the Province of Nova Scotia giving, for the first time in its history, undivided support to the policy of the administration.

In regard to the westerly division, Winnipeg to the Pacific, to be constructed by the Grand Trunk Pacific Company, it is officially announced that work will be commenced at several points next spring. The Pacific port has not yet been definitely determined, but the course of the surveyed routes indicates that the choice lies between Port Simpson and the Kitimat Inlet. The Skeena River is navigable for light-draught steamboats as far as Hazleton, 120 miles from the coast, affording a convenient basis for supply of materials for the mountain section. The Upper Skeena Valley presents engineering difficulties involving heavy outlay, but a favourable route from Hazleton to Kitimat, covered by a local charter, has been secured by the company's agents.

Under its contract with the Government, the company must purchase all material and supplies required for the construction and equipment of the railway from Canadian producers, "when the same are produced in Canada, and when such material and supplies can be purchased in desired quantities and of equal quality suitable for the purposes required, and for prices and upon terms equally advantageous with those procurable elsewhere." Imported materials and supplies will be subject to Customs duties, except as regards direct importations by the Government for improvements on the eastern division.

NEW REGULATIONS FOR DOCKS, WHARVES, QUAYS, AND SHIPS.

UPON the 1st of January, 1905, a series of new statutory rules and orders will come into force for the protection of persons employed in the various processes or operations connected with the management and working of docks, wharves, quays, and the ships frequenting them. A brief review of the leading features may prove of interest.

In September, 1902, the Secretary of State certified, in pursuance of the Factory and Workshop Act, 1901, that the processes of loading, unloading, moving, and handling goods in, on, or at any dock, wharf, or quay were dangerous, and in the following July a certain code of "Draft Regulations" was issued by the same authority. To this code many and serious objections were taken, and in November of the same year Mr. Chester Jones, barrister-at-law, was appointed to hold an inquiry with regard to it, and to report upon it to the Secretary of State.

During the inquiry stage of the proceedings, sittings were held in London, Cardiff, Newcastle, Liverpool, Glasgow, and Belfast. No less than sixty-eight objectors appeared during the proceedings, thus testifying to the importance and magnitude of the inquiry. Most of these appeared in a representative capacity, and objected on behalf of large classes of persons. Dock, ship, and wharf owners, railway and canal companies, and harbour commissioners and trusts attended the sittings. Inspectors of factories, coroners, and experts were called as witnesses on behalf of the Home-office, and working men engaged in the various processes to which the regulations apply gave evidence for the unions. It is unnecessary to enter into the details of the evidence. The conclusions Mr. Jones arrived at were that the processes certified may certainly be classed as "dangerous," and are the cause of a very large number of accidents. Secondly, that the premiums charged for insuring occupiers against claims for compensation for injury to their workmen employed in the processes were very high. It appears that no statistics were supplied, or stated to be available, classifying the accidents and showing the various causes to which they were due.

A number of conferences separate from the inquiry took place at the Home-office, and the draft regulations issued from them in the form and under the title of "Conference Regulations." With the exception of a few outstanding points, there was a close agreement between these two codes, which greatly simplified the task of framing the final form of the regulations to be recommended for adoption in the report. This form is attached to the report under the heading of "Suggested Regulations," which, with a different name, will become law, as stated at the commencement of our article. There are in all thirty-nine sections in these new Rules and Orders, some of which should be more especially referred to. It should be remarked that docks, wharves, and quays are treated as factories for the purposes of these Rules and Orders, by virtue of the Factory and Workshops Act, 1901.

In the definitions, a "shallow canal" includes any of the

following parts of a canal, canalised river, non-tidal river, or inland navigation:—(*a*) Any part having no means of access to tidal waters, except through a lock not exceeding 90ft. in length. (*b*) Any part not in frequent use for the processes. (*c*) Any part at which the depth of water, within 15ft. of the edge, does not ordinarily exceed 5ft. A point strongly contested by some of the dock owners, and agreed to by others with good reason, since it concerns the safety of the employés, related to a provision in the original draft regulations. It was to the effect that, if required by the inspector for the district, life chains should be provided along the dock wall at the water level. It appears to have been assumed by the objectors that life chains were to be provided all round the dock, a scarcely practicable feat. A compromise was effected, leaving it open to the dock owners to provide the means of support or escape from the water. The clause adopted states that "there shall be provided means, at or near the surface of the water, at reasonable intervals, for enabling a person immersed to support himself or escape from the water, which shall be reasonably adequate, having regard to all the circumstances." Sailing vessels not exceeding 250 and steamers 150 tons are conditionally exempted from maintaining gangways or ladders during loading. Sec. 19 of the new rules, which are briefly termed "Regulations," is of consequence. It prohibits the use of hatch coverings for certain purposes. Should they become damaged by their ends, corners, or sides being knocked off, they are no longer safe as a support to persons walking on them when replaced over the hatchway. If they are used as deck or cargo stages, they are clearly exposed to considerable damage, from which they must be protected as in the clause: "Hatch coverings shall not be used in connection with the processes in the construction of deck or cargo stages, or for any other purpose which may expose them to damage."

The most important of the whole twenty-five regulations is No. 6, which relates to the most serious danger to which those working in and on the ship are liable. It deals with the facilities afforded to dock labourers and others to enable them to get from the deck to the hold of the ship. It is observed in the report that "the provision for this purpose is in many cases shamefully inadequate, so much so that other workmen, such as boilermakers and men employed to repair the ship, refuse to descend by the means provided, and insist on being supplied with temporary ladders." In many ships, when men descend into the hold, the winch may be so close to the coamings as to oblige them to climb along the top of the coamings, in close proximity to the winch, which may be in motion at the time. They are then compelled to lower themselves over the coamings in the best way they can, and feel about with their feet for the ladder, which may be recessed to a considerable extent under the deck. The next difficulty, the ladder being gained, is to find room for either hand or foot, in cases where the cargo is stored hard up against the ladder. Should the men succeed in reaching the 'tween deck safely, they may discover that the next ladder is not in line with the one from the upper deck, but some few feet to the right or left of it. Should the men assume, as is reasonable when the hatchways of the upper and lower deck are of the same size, that the ladders are in a line, they might fall to the bottom of the hold. That these are serious and obvious dangers no one will deny.

The shipowners and the labour representatives fought over this question. What the latter party contended for was practically a continuous ladder reaching down in the clear of the hatchway. To this provision the shipowners were strongly opposed, and brought forward a considerable amount of evidence in support of their objection which we need not reproduce. By the adoption of a middle course the matter was finally arranged. It consisted in so amending the Conference regulation, by the addition of four sub-clauses, that the dangers alluded to would be sufficiently guarded against pressing unduly upon the shipowners. It is provided that so much of Regulations 6 and 8 as require structural alterations shall not come into force until the first day of January, 1908. The delay in this instance is very properly conceded, so as to enable ships to find an opportunity for effecting them. Vessels employed in the catching and unloading of fish are exempt from Parts 2—6, inclusive, of these regulations.

THE POLLAK-VIRAG RAPID TELEGRAPH.

IN our issue of January 11th, 1901, we described the Pollak-Virag Rapid Telegraph, which was shown in operation at the Paris Exhibition. Since that time the system has been much improved in detail, and a demonstration of its working was made last Friday at the Carlton Hotel. It may be of interest if we add a few descriptive words to what we have already written on this subject, and all the more so because we are now enabled to publish some drawings which render the explanation of the various instruments employed more readily understood.

In the first instance we may perhaps recall to our readers' memory the fact that in this system messages are transmitted by means of a specially perforated band of paper, and are reproduced at the receiving end in flowing writing. The paper is perforated in an instrument not unlike an ordinary typewriter, so far as its keyboard is concerned. The depression of a key representing any one letter perforates in the band of paper, as it passes through the instrument, the holes or combination of holes necessary to ensure the proper formation of this letter at the receiving end. It will be readily understood that all letters may be formed by a proper combination of horizontal and vertical motions. Exactly how this fact is made use of in the Pollak-Virag system will be appreciated by an examination of the accompanying Fig. 1. This shows at the top a reproduction, to a reduced scale, of a ribbon perforated so as to transmit the words "dans le systeme de telegraphie." It will be noticed that the perforations, as represented by the black dots, are grouped into divisions corresponding to the horizontal spaces lettered *a*, *b*, *c*, *d*, *e*, and *f*. The significance of this will be more apparent when we describe the transmitting apparatus. Below the perforated strip of paper will be seen first of all a reproduction of the vertical components necessary for the formation of the letters of the words of the message. Below this are given the horizontal components of the letters, and below this again the actual message as it is delivered at the receiving end. We are enabled to give in Fig. 2 the facsimile of a portion of the writing as produced by the instruments at the Carlton Hotel on the occasion of our visit. It will be seen that the writing is on a slant, the reason for this being, of course, because the sensitised paper on which the message is being impressed is continually travelling. We will explain later on how the ray of light, having travelled to one end of a line, begins again at the other side of the paper for the next line.

Fig. 3 shows in diagrammatic form the transmitting arrangements. The perforated slip P is passed over a roller R, being pressed against the latter by means of brushes B_1 and B_2. The roller R is made up of six metallic rings, *a*, *b*, *c*, *d*, *e*, and *f*, separated from one another by insulating pieces, but forming a smooth and compact surface. The brushes B_1 and B_2, which are, of course, insulated from one another, are so formed that when a perforation comes between one of them and the roller, a small portion of the brush springs momentarily through the perforation, and makes

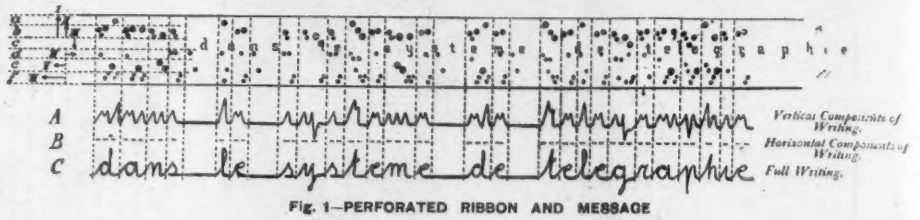


Fig. 1—PERFORATED RIBBON AND MESSAGE

contact with the metallic ring. Saving when this happens the brushes are kept insulated by the paper band from the roller, and no current passes. The brush B_1 covers the three rings *a*, *b*, and *c*, and the brush B_2 the rings *d*, *e*, and *f*. The perforations on the paper band are arranged in such a manner that, of the two groups *a*, *b*, *c*, and *d*, *e*, *f*, only one ring at a time can be operative at any one instant. The rings *a*, *b*, *c*, *d*, *e*, and *f* are metallically connected to the wires 1, 2, 3, 4, 5, and 6 respectively, and these, in their turn, are connected to various positions I., II., III., and IV., V., VI. of the two batteries shown. It will be seen on examining the

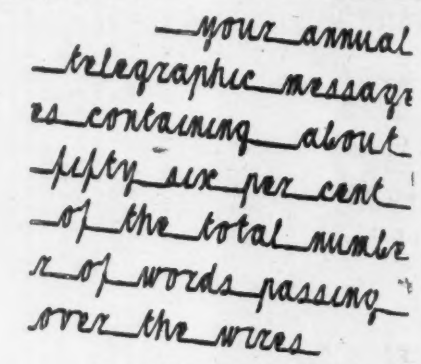


Fig. 2—FACSIMILE OF WRITING

connections that a number of circuits differing in pressure and direction of current are thus involved.

At the receiving end there is a mirror reflecting a spot of light light on to a band of sensitised paper, which is continually being moved forward by the action of a motor. Surrounding the source of light, which is an incandescent lamp with a long straight filament, is a metallic screen with a helical slot cut in it. This is so masked that the light can only pass through a small portion of it at one time to be projected on to and reflected by the mirror. The same motor which actuates

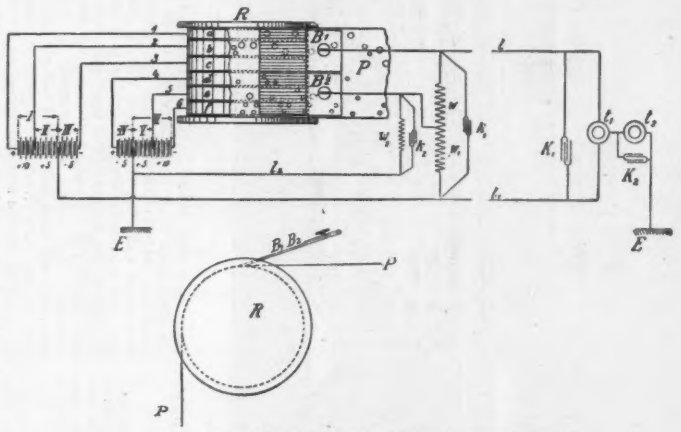


Fig. 3—DIAGRAMMATIC DRAWING OF TRANSMITTER

the paper-revolving mechanism revolves this screen with its helical slot. The result is that the point of emission of the light is made to travel in a horizontal line from one side to the other. Naturally, also, the spot of light also travels in a horizontal direction, and if the mirror is kept steady a line is produced when the sensitised paper is developed. The brains of the whole apparatus, so to speak, are a couple of telephones. These are designated t_1 and t_2 in Fig. 3. Attached to their diaphragms are two rods, shown at *x* and *y* in Fig. 4. Fastened to these are two spring pieces *s* and *w*, and they impinge on the back of the mirror already mentioned. They are arranged in a peculiar manner, for the mirror, being fixed to the extremity of the spring piece *u*, the spring piece S impinges on the back of the mirror vertically above the point of fixture, while the spring piece W impinges on the back of the mirror in a horizontal line relatively to the point of fixture. Accordingly, movements of the telephone diaphragms

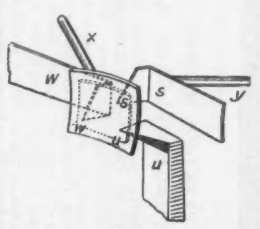


Fig. 4

will produce in one case vertical and in the other case horizontal movements of the mirror. Consequently, vertical and horizontal movements of the reflected spot of light are also produced. It will be evident, therefore, that providing the telephones can be properly energised, the requisite motions to produce actual letters may be produced.

The duty of the battery designated I., II., III. is to actuate the telephone t_1 and that of the battery IV., V., VI. the telephone t_2. The telephone t_1 in the receiver is placed in the loop formed by the two-line wire *l* and l_1 to which the rings *a*, *b*, *c*, with the connections 1, 2, 3, as well as the battery I., II., III., are connected in parallel between the brush B and the live wire *l*. Fig. 3 shows the connections of the remainder of the circuit, including telephone t_2. In this figure K_1 K_2 are condensers and W, W_1, W_2 are coils containing self-induction. The telephone t_1 is so wound that equal and opposite currents counteract one another. It will be evident, therefore, since W and W_1 are so arranged, that no matter what current be flowing in the earth wire there are currents of the same strength in *l* and l_1, and that impressions can be made on the diaphragm of t_2—and hence the reflecting mirror—without disturbing the diaphragm of t_1. Moreover,

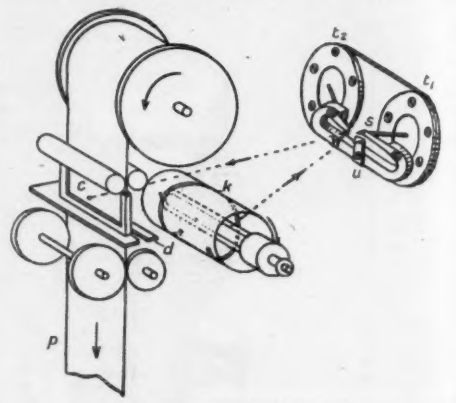


Fig. 5—RECEIVER MECHANISM

the arrangement of the various connections is such that signals can be made to affect t_1 without also affecting t_2. With this much explanation it will be clear that, providing impulses of correct length and direction be despatched by the transmitter, they will be reproduced by the mirror and ray of light in the receiver.

The slot in the screen covering the source of light is so formed that before the reflected spot of light travels off the paper at one side it has reappeared at the other side through the other end of the slot. The receiving mechanism will be better understood by reference to Fig. 5. Here will be seen the ends of the telephones t_1 and t_2. The spring pieces *s* and *w*, the mirror attachment *u*—the mirror itself not being shown—the lamp *l*, the screen *k*, with its helical slot, the band of sensitised paper *p*, and the shears *d* for cutting off portions of the paper. The reflected spot of light is shown at *c*. It will be seen that as *k* revolves the point *c* will continually travel across the paper in one direction, disappearing at one side and reappearing at the other.

The foregoing is, in simple words, an explanation of the working of this ingenious combination of instruments. Whether or not they will come into extended use it is impossible to say. There seems to be no doubt that a rate of transmission of 40,000 words per hour is obtained. The message is delivered in readable writing. The image on the sensitised paper is developed and fixed in the receiver and wound out of it in some 15 seconds. The paper itself is about 2¾in. wide, and the writing practically fills it from side to side. There is no room, saving between the lines, for alteration or arrangement of the message. Moreover, the surface of the paper, especially when it is more or less wet, does not lend itself to corrections in ink being made. In addition to the foregoing, three wires, or two wires and an earth return, are required for the working of the apparatus, and only one copy of the message is made at the receiving end. Whatever its final commercial value, however, one cannot but be struck with the ingenuity displayed in every detail of the whole system.

THE Conakry-Niger Railway in French Guinea has made good progress, and although unforeseen difficulties prevented its being opened to Kindia in 1903, this was done in May, 1904. The second section, which will not go to Timbo, but take an easier route to one side, has been started, the necessary funds being provided from the loan of £2,600,000 made by the Government General. The work will be pushed on vigorously, but the whole of the second section is in mountain country, and there are many difficulties to be overcome.

RAILWAY MATTERS.

THE Manila electric traction system is to be extended about five miles in the suburbs of that Philippine city.

THE car works in Riga are building a number of armoured passenger cars for the Chinese Eastern Railroad.

THE number of men now at work in the Schenectady Locomotive Works is about 3000, most of these having been taken on during the past few weeks.

IT is the intention of the St. Louis South-Western Railroad Company to build an extension south-east to the Sabine River and eventually to Beaumont.

THE Boston (U.S.A.) Elevated Railroad Company is arranging to build an elevated extension from Guild-street, Boston, to Forest Hills, about 2½ miles.

THERE was an influential meeting at Aberystwith last week to promote a line of railway from Aberystwith to Aberayrow, and the movement was warmly supported.

THE authorities of the Congo Free State are endeavouring to popularise travel through their territory, and the Congo Railway Company have reduced the rate for first-class fare to £2 for a journey of 240 miles.

THE contract for the conversion of the Belfast tramways to electricity has been given to Messrs. J. G. White and Co. The tramways were recently purchased by the municipality, and the value of the contract is about half-a-million sterling.

THE New York, Pennsylvania, and South-Western Railroad has given out a contract for building part of the proposed line from Williamsport, Pa., north-east to Binghampton, N.Y., 116 miles. Work on the Pennsylvania end is already in progress.

SOME indignation is felt by steelmakers on account of the Great Northern Railway Company's decision to let a contract for 5000 tons of rails to the United States Steel Trust. A Leeds firm has received an order for 2000 tons, but Sheffield has been passed over entirely.

AN issue is announced in Berlin of 21 million marks shares of the East African Railway, an undertaking formed to construct railways and harbours in German East Africa. The shares bear a guaranteed minimum dividend of 3 per cent. from the Imperial Government.

DURING the first twenty-nine days of its operation of the New York subway, the Interborough Rapid Transit Company has carried 5,838,235 passengers who have paid fare, in addition to a small number who travelled on passes and the larger number of policemen and firemen who travel free.

ADVERTISEMENTS are to be strictly regulated as to size, position and manner of exhibition in the newly opened New York underground railway. No advertisements are to be allowed below the frieze line on the side walls of the stations alongside the lines. Automatic machines are also to be banished from the stations, on the ground that they are obstructions.

FORTY-SEVEN persons were killed by cars—railroad trains, 34; street cars, 13—in Chicago in October, according to the report of the Coroner. The total number of accidental deaths was 107, so that the persons killed by cars constitute 44 per cent. of the whole number of accidents. The total number of deaths with which the Coroner had to deal was 233.

THE receipts of the Ceylon Government Railway for 1903 were the largest on record, namely, Rs. 8,338,614. The train mileage was increased by 109,866 over the previous year. The length of new lines opened was 23¾ miles. The total length of line open for traffic at the end of the year was 391¾ miles, viz., broad gauge 331⅜, and narrow gauge 60⅛ miles.

AT the end of the present year Mr. H. G. Drury will retire from the position of chief superintendent of the Great Eastern Railway, a post he has occupied since 1897. He will be succeeded by Mr. R. P. Ellis, the present assistant superintendent. Mr. Drury entered the services of this line in 1853, when it was known as the Eastern Counties Railway.

THE Russian Minister of Ways of Communication has issued orders to the effect that for the future only persons of advanced education are to be appointed chiefs of the various sections of the Russian railways. This is a step in the right direction, for the railway system of Russia suffers greatly from the low state of education on the part of the staff generally.

BETWEEN Dayton, Ohio, and Richmond, Ind.—42 miles—electric cars are now run, over the Dayton and Western, twice each way daily on an express schedule with only two stops, and the time is 1 hour 20 minutes. These trains go by the name of the Interstate Limited, and each car has a buffet from which luncheons are served, and an observation room at the rear end.

THE Pennsylvania Company has just closed orders for 6000 freight cars, according to statement given out in Philadelphia, November 25th. The orders have been given to the Pressed Steel Car Company, the Standard Steel Car Company, and the Cambria Steel Company, of Johnstown. This makes 12,000 cars ordered for the Pennsylvania system within the last thirty days.

THE gross earnings of 87 American railways for the month of October show a gain of £591,382 over the same month in 1903. This compares with a gain on 91 roads in September of £517,955, and on 87 roads in August of £310,040. Of 65 of the more important railroads reporting earnings for October, 42 show increases and 23 decreases; but the losses, with only a few exceptions, are small.

THE net revenue of the Great Indian Peninsula Railway in the year ended June 30th amounted to Rs. 2,62,81,867. After meeting prior charges, a sum of Rs. 58,30,861 is left to be divided between the Government and the company, of which the company receive Rs. 2,91,543. The directors propose a dividend of 15s. per cent., in addition to the guaranteed interest, leaving £64 to be carried forward.

EXPORTS of American locomotives for the nine months ending with September reached 394, with a total valuation of £737,257. This is an increase in number of 193 and in value of £276,218 over the same period of 1903, and of 118 over 1902; Mexico, British North America, and Japan, in the order named, are the three largest importers of locomotives from the United States. For the period referred to Mexico imported from the United States 134 locomotives, as compared with 62 in the same period for 1903, and 89 for 1902. British North America imported 117, as compared with 87 in 1903 and 76 in 1902.

Two fast railway runs are reported from America. On Monday, November 14th, a westbound fast mail train of the Pennsylvania Railroad was run from Harrisburg to Altoona, 132 miles, in 132 minutes. This train usually consists of three mail cars, weighing about 160 tons. On Friday, November 11th, a special train was run over the Pennsylvania lines from Crestline, Ohio, to Fort Wayne, Ind., 131·4 miles, in 113 minutes, equal to 69·8 miles an hour. The train consisted of an "Atlantic" type engine, weighing, with tender, 163·5 tons, and three cars. From Crestline to Clarke Junction, 257·4 miles, the time was 245 minutes, making the rate of speed 63 miles an hour. Excluding stops it was 64·9 miles per hour.

NOTES AND MEMORANDA.

IT has been estimated that the total amount of water power actually used for electrical production throughout the world at the present time must exceed 2,000,000 horse-power.

IN the month of October 380 vessels passed through the Suez Canal, against 336 in the corresponding month of last year. The takings amounted to 10·3 million francs, against 9·4 millions.

THE total imports of machinery and vehicles into Switzerland from all countries amounted last year to £1,182,200, of which the United Kingdom supplied £83,600, being an increase of £5600 on her exports in 1902.

THE largest number of hands employed by any single motor car works in this country is 1300, and it is computed that there are 20,000 persons directly or indirectly employed in the British motor car industry to-day.

WE understand that Prof. Hele-Shaw has accepted the post of principal organiser under the Transvaal Technical Council for one year, and has, in consequence, resigned the chair of professor of engineering at Liverpool.

THE number of vessels which used the North Sea and Baltic Canal in October was 3107, measuring 530,917 registered tons net, against 3144 ships and 495,571 tons in October, 1903. The dues collected amounted to 275,719 marks, against 252,354 marks.

IT is reported that the Secretary of State for India has sanctioned the creation of the appointment of electrical adviser to the Government of India, with headquarters at Calcutta. The present post of electrical engineer to the Government of Bengal will be abolished.

THE registrar of the University of Leeds announced, at a Mansion House meeting held at York on November 30th in support of the University, that £61,825 has been subscribed towards the £100,000 required to make the necessary additions to the buildings and to increase the endowment of the University, so as to satisfy the financial requirements laid down by the Committee of the Privy Council.

IT is remarkable that the effect of alloying iron with another element, even a better conductor, is always to reduce both the thermal and the electrical conductivities. The ratio of the two conductivities is, however, not exactly the same for all alloys; on plotting the electrical against the thermal conductivity, a fairly smooth parabolic curve is obtained, showing that the ratio increases in magnitude as the conductivity of the alloys increases.

THE report on the condition of the Metropolitan Water Supply during the month of October, 1904, by the water examiner appointed under the Metropolis Water Act, 1871, states that the average daily supply delivered from the Thames during the month was 122,922,724 gallons, from the Lea 52,142,742 gallons, from springs and wells 43,493,555 gallons, from ponds at Hampstead and Highgate 34,494 gallons. The daily total was, therefore, 218,593,515 gallons for a population estimated at 6,533,058, representing a daily consumption per head of 33·46 gallons for all purposes.

THE first-class battleship Britannia was launched from the building slip at Portsmouth Dockyard on Saturday. She is a ship of the King Edward VII. class, and was laid down on February 4th last. Her launching weight is 5000 tons, and the armament to be placed aboard her will include four 12in., four 9·2in., ten 7in., and ten 6in. guns. She will have an ultimate displacement of 16,350 tons. The engines are capable of indicating 18,000 indicated horse-power, and will drive her at the rate of 18½ knots. Her length is 425ft., and her "all over" measurement 453ft.; beam, 78ft.; draught, 26ft. 9in.

A NEW hemp-stripping machine has been recently invented by Mr. Robert E. Lindsay, a young American engineer. Hemp-stripping by hand is so violent and exhausting that the native can work only every other day, requiring the alternate day and two nights in which to recover from the lameness and exhaustion produced by one day's work. It is said that two men working with the machine can clean as much hemp in four hours as they could clean in four days by hand, and the fibre is of a much better quality, being clean, white, and silky. The machine is so light that it can be carried over hill and swamp by four men.

PROJECTILES fired against plates usually fail, or show weakness near the bourrelet, as made evident by upsetting or by an increased diameter. This is due to the heavy base and walls advancing on the point when the projectile is suddenly stopped by coming in contact with the plate. The Bethlehem Steel Company has endeavoured to correct this defect by decreasing materially the weight of the base, and by strengthening the walls against deformation by interior longitudinal ribs. They expect to obtain the same penetration with this projectile as with the standard, with a considerable increase in the volume of the interior cavity.

THE quantity of American cotton received at Manchester this season amounts to 154,464 bales, an advance of 10,000 bales on the amount received on the corresponding date a year ago, but 5000 bales fewer than the record in the best season known—1902-3. So large is the quantity of American cotton expected before the end of the year, however, that it is believed that a new record will be established. In the Egyptian cotton department the season is the best that the Manchester Ship Canal has experienced. The number of bales discharged already is 44,786, or 3000 more than on the corresponding date last year, and 4000 more than the year before.

BLACK powder for ignition and saluting purposes and for filling shell is still used in the United States navy, but its manufacture for other purposes has been wholly discontinued. All brown powder has been withdrawn from service and replaced with smokeless powder. Cordite, which was purchased during the Spanish War, has been withdrawn from service and will eventually be destroyed, as soon as the guns of foreign make, which alone now use it, have been replaced by guns of our navy pattern. Cordite has not proved satisfactory. Its ballistics are uncertain, and it is, in addition, objectionable on account of its great erosive effect on the bores of guns.

THE new lighthouse at St. Catherine's Point, on the edge of Pennybney Cove, has an excellent situation, as the light may be seen by every passing vessel all the way from Plymouth, and on the western side its rays will be observable beyond Dodman Point. The light is dioptric, white, flashing, of the fourth order, with red sectors. The intensity of the red and white lights will be 1700 candle-power. Gas is the illuminant, and the light will be unattended by night. In clear weather it will be visible from a distance of 15 nautical miles. The focal plane of the light is elevated 91ft. above high water of ordinary spring tides, while the fane is 100ft. above sea level.

THE following list of the world's water-power electricity installations shows the aggregate power so obtained in the respective countries:—United States of America, 527,467 horse-power; Canada, 228,225 horse-power; Mexico, 18,470 horse-power; Venezuela, 1200 horse-power; Brazil, 800 horse-power; Japan, 3450 horse-power; Switzerland, 133,302 horse-power; France, 161,343 horse-power; Germany, 81,077 horse-power; Austria, 16,000 horse-power; Sweden, 71,000 horse-power; Russia, 10,000 horse-power; Italy, 210,000 horse-power; India, 7050 horse-power; South Africa, 2100 horse-power; Great Britain, 11,906 horse-power—total, 1,483,390 horse-power.

MISCELLANEA.

AT the late meeting of the Mersey Docks and Harbour Board it was announced that Mr. George B. Proctor, chief traffic manager, would retire at the end of the year.

THE new engineering plant lately added to the Municipal School of Science and Technology, Richmond-terrace, Brighton, will be inaugurated by Sir William White, K.C.B.

THE Nottingham City Council have decided to widen Trent-street, and to construct a new bridge over the canal, and they have decided to erect a refuse destructor at Basford at a cost of £23,300.

THE Eiffel Tower is next spring to be connected by a wire rope 500 m. long with a pylone or obelisk, for studies in connection with the problem of flight, by means of an electromotor and a dynamometer.

THE Thames Conservancy have passed the clause of the Bill for the deepening, widening, and improvement of the bed and channels of the Thames, and which provides for borrowing powers up to £3,000,000.

A COMMITTEE of the Liverpool Chamber of Commerce is considering a proposal by Professor Royce, of Liverpool University, to establish in this city a commercial museum and bureau of scientific information.

THE Bradford Electricity Committee are discussing a report on the distribution of electricity by the city electrical engineer, Mr. Alfred Blackman, which contains recommendations involving an expenditure of over £40,000.

THE Bowland Rural District Council, at their meeting this week, adopted a scheme, estimated to cost £2450, for the purification of the sewage of the township of Waddington, near Clitheroe. The treatment will be by bacteria beds.

AT Wednesbury, on Wednesday last, Messrs. Jesse Tildesley and Co., bridge and girder manufacturers, Darlaston, were fined £5 and costs for omitting to have their boilers inspected within fourteen months, as required by the Factory Act.

THE Local Government Committee of the London County Council have reported that the valuation in force on April 6th next would be £50 438,868 gross, and £41,657,244 rateable, an increase of £665,526 and £570,270 respectively.

THE Yarmouth Town Council decided, by a large majority, this week to accept a Belgian tender for between 800 and 900 tons of steel rails for the new electric tramways, at 95s. per ton, the lowest English tender being at 104s. 6d. per ton.

THE Derby Town Council intend to apply for sanction to borrow £30,000, being the further amount required for sewerage purposes, in addition to the sum of £290,000 specifically authorised to be borrowed under the Derby Corporation Act.

Two new Transatlantic liners shortly to be put on the stocks for the Hamburg-American line are to be fitted with passenger elevators. From the lowest saloon deck to the boat deck of the two ships represents the height of an average five-storey house.

THE twelfth annual dinner of the past and present apprentices of the Hammersmith Ironworks—Gwynne's Limited—will take place at the Trocadero on Friday, December 23rd, Mr. John Gwynne, in the chair. It is hoped that as many past apprentices as possible will be present on this occasion to support him.

PETROLEUM has been sought for in twenty-seven counties in California, and of these twelve have yielded nothing, six have yielded oil in small quantities, one is a doubtful success, while seven are now producing oil profitably. In the seven counties just referred to there are fourteen distinct centres of production.

AN address on "The Recent Visit to the United States and Canada," will be delivered by Sir William Henry White, K.C.B., past-president, at the ordinary meeting of the Institution of Civil Engineers, on Tuesday, the 10th January, 1905, at 8 p.m. The address will be repeated on the following day, at 3.30 p.m., for the benefit of members and their friends.

ACCORDING to a table just compiled by Mr. James Carter, the borough treasurer of Preston, the inhabitants of Wolverhampton are the most heavily rated of any town in England. In this town the total rates amount to 10s. 1d. in the pound West Ham, 9s. 10d; Norwich, 9s. 7d.; East Ham, 9s. 6d.; and Halifax, 9s., stand next in order. The lowest rated boroughs are those of Lancaster, where the rates only amount to 4s. 6d.

A RECENT extension of the work of the City of Bradford Technical College is in the direction of apprenticeship courses, in which students during their apprenticeship attend part of their time at the College and the remainder in the workshops of their masters. A movement on these lines has been organised jointly by the Engineering Employers' Federation and the College, and there are signs that similar arrangements will develop in connection with other industries.

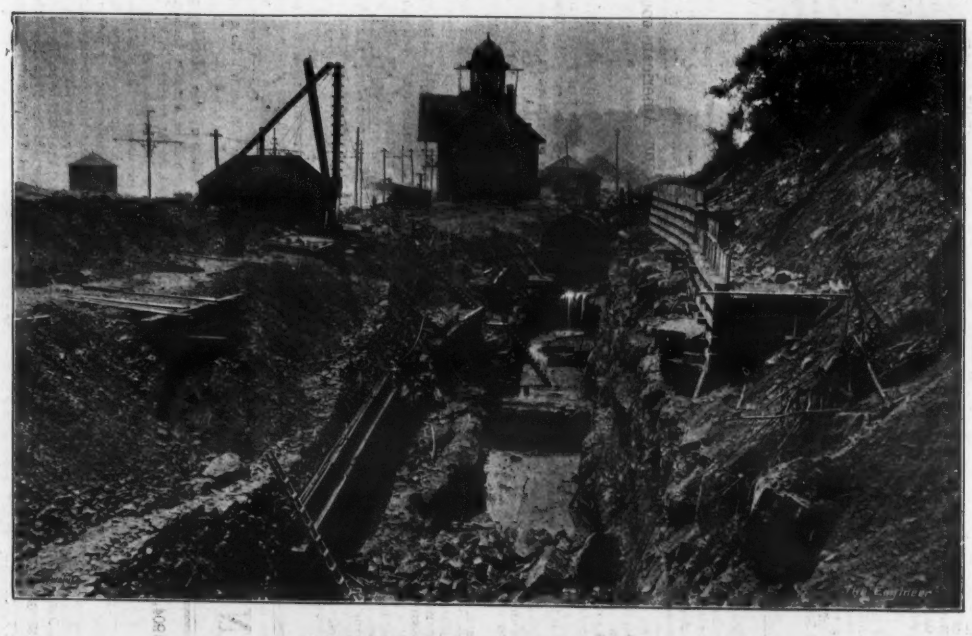
GRAVE anxiety has been felt by the inhabitants of Freshwater, Isle of Wight, during the past week on account of the serious encroachments made by the sea. The tides have been unusually high, and the strong winds have carried in huge waves, causing much damage to the esplanade. An enormous mass of concrete has been carried away from the sea wall, causing some anxiety as to the security of the foundations of various properties. It is feared that, unless prompt steps are taken, the sea may break through the low land to Yarmouth, and thus create two islands.

THE Odessa Press announces that when the war is finished the so-called "Volunteer Fleet" will be reorganised entirely. Not only will the number of the larger steamers be increased considerably, but a more practical turn is to be given to the working of the fleet. In the first place, the steamers are to be sent on longer voyages to foreign countries, and the authorities hope that they will succeed in capturing a great portion of the passenger and goods traffic, especially between Russia and the United States. For this purpose, and especially as Moscow has just been connected by rail with the new port of Windau, in Courland, it is regarded as being almost a foregone conclusion that Odessa will be given up as the base of the "Volunteer Fleet," and that in its stead either Libau or Windau will be chosen, and great changes will be made in the staff of the fleet.

THE organising committee of the Mediterranean motor boat race, the president of which is Senator Barbey, has decided that (1) it shall be contested, so far as possible, by day and in two cruises, Algiers to Mahon 198 miles, and Mahon to Toulon 207 miles, the start being regulated by the state of the weather; (2) the sea-going qualities of the competing vessels must be proved by preliminary trials; (3) all the competing motor boats—those, for instance, entered in the Monaco regatta—may engage in the Nice-Toulon and Toulon-Marseilles races, as also in any arranged at Nice, Toulon, and Marseilles; (4) the start from Nice is to immediately follow the close of the Monaco Motor Boat Exhibition; (5) vessels competing in the Algiers and Toulon race must be provided with the committee's certificate of qualification before the start from Algiers; and (6) both in the principal race and those preceding it, competitors must conform to the instructions of the competent authority, so as to render effective the protection afforded by the escorting torpedo-boat catchers.

WATER POWER DEVELOPMENT AT NIAGARA

(*For description see page 593*)



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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Ten o'clock on Tuesday morning in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

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PUBLISHER'S NOTICES.

*** *With this week's number is issued as a Supplement, a Two-page Drawing of a High-duty Pumping Engine, Shanghai Waterworks. Every copy as issued by the Publisher includes a copy of the Supplement, and subscribers are requested to notify the fact should they not receive it.*

*** *If any subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

MONORAIL.—We would suggest that you should apply to Mr. A. Bouchier, 22, Lawrence Pountney-hill, E.C.

H. H. (King's Lynn).—You might safely let the two rods take a load of 70 tons. Each rod would break with a load of approximately 100 tons.

G. N. E. (Dundalk).—You can obtain full particulars from the secretary to the Municipal and County Engineers' Institute, 11, Victoria-street, Westminster.

D. (Billinhurst).—The motor coaches on the Marienfelde-Zossen line were made by Messrs. Van der Zypen and Charlier, of Cologne. They were seated each for fifty passengers.

J. P. (Lewisham).—See Ewing Matheson's "Depreciation of Factories," Spon; and Burton's "Engineering Estimates and Cost Accounts," Technical Publishing Company.

J. (Exeter).—Your pump valves thrash because they have too much lift. Try screwing down the centre pins with which you say the valve-boxes are fitted; but be careful, for unless there is a relief valve fitted, you may have a catastrophe.

W. P. (Earlsfield).—By far the best way to test your propeller lies in hiring a small steam yacht or river launch by the month, fitting her with your screw, and testing her on one of the measured miles below Woolwich. You can get such a boat through any of the yacht agents, of whom there are several.

T. S. (Landore).—Probably vanadium. Consult a good metallurgical chemist. We do not think that any accurate statistics of tungsten are available; possibly, 700 or 800 tons of it may be used every year, principally in Europe in steel making. The ore is fairly distributed over the world. Aluminium is sometimes used to get rid of floating dross in casting chrome steel ingots. A small piece thrown into a crucible vanishes almost explosively; possibly it acts as a deoxidiser.

C. Y. (Oldham).—We do not think it is fair to denounce a bygone race of employers as you do. Take, for example, that cited by yourself, dry grinding. It is a fact that the needle grinders of Redditch offered the most determined opposition to all attempts to introduce magnetic shield respirators or suction fans. The grinder earned about £5 a week, died of grinders' asthma at 35, and saw very clearly that if the occupation became less lethal he would get less money. Do you know that in the present day it is almost impossible to get men to use saw guards?

J. J. M. W.—(1) For induced draught work, we cannot advise you to put down a fan running at 600 revolutions per minute. These fans are liable to rapid destruction by heat, sulphur fumes, and dust, and centrifugal effort acting on deteriorated metal may have a disastrous effect. A fairly large fan running at 300 revolutions per minute, driven direct by an engine running at the same speed, will, in the end, be more satisfactory, although the whole plant may cost a little more to begin with. (2) There is no practical advantage gained by using one pressure more than another in heating tanks. You will find 50 lb. or 60 lb. answer very well.

INQUIRIES.

WAGES TABLES.

SIR,—Can any of your readers inform me where I can obtain tables of wages for nine hours at various rates? I know books are obtainable, but it would be a great saving of time if tables in regular tabulated form could be bought.

December 14th. TIMEKEEPER.

ERRATA.

In the article "Nile Irrigation, No. III.," in the issue of THE ENGINEER of 23rd September last, column 2 bottom, and column 3, 22nd line, the depth of evaporation of Lake Victoria should be "1·77" instead of "1·42." The error arose from the figure of 85,000,000,000 being used in the calculation of the depth instead of 68,000,000,000; the latter being the area of the lake, while the former is the quantity of rainfall on the lake surface.

By the accidental omission of the word "no" in our description of Mr. T. M. Jarmain's new swath turner, which was included in the article on the Smithfield Show last week, an unintentional injustice was done to Mr. Jarmain. The sentence referred to should read "This machine being designed in a manner which, while retaining the good features of the earlier machine, is lighter in draught and sufficiently narrow to pass through a 7ft. gateway, while there is no likelihood of choking when dealing with heavy crops."

MEETINGS NEXT WEEK.

INSTITUTE OF MARINE ENGINEERS.—Monday, December 19th, at 8 p.m., at 58, Romford-road, Stratford, E. "Fuel Testing."

SOCIETY OF ARTS.—Monday, December 19th, at 8 p.m. Cantor lectures: IV. "Musical Wind Instruments," by David James Blaikley. Tuesday, December 20th, at 8 p.m. Applied Art Section: "Street Architecture," by Thomas Graham Jackson, R.A.

THE ROYAL SCOTTISH SOCIETY OF ARTS.—Monday, December 19th, at 8 p.m., at 117, George-street. Communication "On Ben Nevis and its Observatories," by Gilbert Thomson, M.A., Assoc. M. Inst. C.E., Representative of the Royal Philosophical Society of Glasgow on the Directorate of the Observatories.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 20th, at 8 p.m. Ordinary meeting. Discussion, "On the Construction of a Concrete Railway Viaduct," by Arthur Wood-Bill, Assoc. M. Inst. C.E., and Edward Davy Pain, B.A., Stud. Inst. C.E. Wednesday, December 21st, Students' visit to the Printing Works of Messrs. Wm. Clowes and Sons, Limited, Duke-street, Stamford-street, S.E.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, December 21st, at 7.30 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Ordinary meeting. Discussion on Mr. F. J. Brodie's Paper "Decrease of Fog in London during Recent Years." Paper, "The Study of the Minor Fluctuations of Atmospheric Pressure," by W. N. Shaw, D.Sc., F.R.S., and W. H. Dines, F.R. Met. Soc.

THE FARADAY SOCIETY.—Wednesday, December 19th, at 8 p.m., in the Library of the Institution of Electrical Engineers, 92, Victoria-street, S.W. Papers: "The Electric Furnace, its Origin, Transformation, and Applications (Part II.), by Adolphe Minet. "Electrolytic Analysis of Cobalt and Nickel," by F. Mollwo Perkin and W. C. Prebble. "The Electrolytic Preparation of Tin Paste," by F. Gelstharp. "Note on the Electrolytic Recovery of Tin," by F. Gelstharp.

THE ENGINEER.

DECEMBER 16, 1904.

THE PREMIUM SYSTEM AND THE FOUNDRY.

THAT the premium system is opposed by the Moulders' unions is common knowledge, but it is only within the last few days that an official order has been made by the Secretary of the Friendly Society of Ironfounders as to the attitude which the members of the Society are to take with regard to it. The attitude is one of uncompromising hostility. It has been agreed between the representatives of English and Scotch ironfounders' unions that wherever it is sought to introduce the system into any moulding shop it must in every instance be opposed, and in order to leave no doubt as to their opinion, the unions hasten to endorse the views expressed by the Engineering and Shipbuilding Trades Federation, which were widely discussed not many months ago. It is impossible not to regret and deprecate this foolish animosity to a system which, wherever it is in use, is not only approved, but absolutely sought for by the men. Its use in foundries is, it is true, so far very limited, but it has been tried in some places for many months, and has proved itself a benefit both to the moulder and his employer. To find any arguments against it the men are driven back on theories which practical results have exploded, and assumptions which hundreds of their fellows could readily disprove. We fear there is still a lurking suspicion amongst workmen that there must be something underhand about a system which offers them so much. They are in constant dread of being "done" somehow by their employers, and rather than trust their own opinion of a subject which is perfectly open and above board, they prefer to believe that it contains some subtle trick to catch them, and hence refuse to have anything to do with it. We can only devoutly hope that they may purge their minds peacefully of any such unwarranted suspicion.

At the time that our unions are passing their restrictive resolutions at home, their fellows in America are in a life-and-death struggle with their employers. Last week brought news of the abrogation of the New York agreement. Conciliation had been tried and found wanting, and the employers had boldly stated their determination to manage their foundries in their own way. All over America there is a strong determination to have the "open" shop—the shop, that is, where unionists and non-unionists work side by side, and where no restrictions as to who shall or who shall not do certain jobs or use certain machines are tolerated. "Organised labour," says a Buffalo paper, "is facing a crisis of tremendous import—the utter surrender of the closed shop. Organised capital banded into a great army that reaches from Hell Gate to the Golden Gate is making formidable headway in its fight for a principle—the principle of the open shop." This is, in spite of its picturesque setting, a literal statement of fact. A vast association has been formed with the object of protecting industry, and its first great object will be the overthrow of the abused power of the American unions. To what extent this power is employed we have, here, but indifferent ideas, but such were the disturbances in Chicago, that at one time it appeared as if the greater part of the whole industrial capital would leave the city. Mr. Job, the secretary of the employers' federation of Chicago has stated that there were no less than 1300 strikes in the city during 1903, and scarcely one of these was conducted without violence in one form or another. It is, moreover, affirmed that there is a regular "schedule of prices paid to professional sluggers of non-union men—so much for a broken rib, so much for a fractured skull, so much for total disablement." Allowing something for the exaggeration which comes naturally to our American cousin when he is attempting to establish a record, even for wickedness, there can be no doubt that Chicago is only now shaking off an unenviable reputation for fostering socialists and anarchistic labour agitators. It is not, under the circumstances, a matter of surprise that from every hand we hear of the determination to defeat the closed shop.

It should not be difficult for our own foundrymen's unions to find food for reflection in these American events. The removal of the restrictions which have bound the foundries will mean the cheapening of foundry products and the probable extension of business. Less men will not be employed than hitherto, but more; less money will not be earned per man, but more. But each man, by the freer use of machines and by the introduction of improved wage systems, will be induced and enabled to do more work. High wages rule in America, and the use of machines and cheap labour is of more consequence than here; but we, on the other hand, have to contend with conditions not known on the other side of the Atlantic, and it is as important to us that our foundries should be run economically as it is to the American. We wish we could persuade the Friendly Society of Ironfounders that they will do more for their own good and for the good of the trade by endeavouring to assist the masters to reduce the cost of their products than they do by hampering and hindering in every way in their power his efforts to compete successfully with his foreign opponents. We were told not long ago at Baldwins' Locomotive Works that their piece work hands had come, at a time of trade slackness, to the management and asked that

their rates might be reduced, as thereby they hoped that the company, by quoting lower prices, might be able to secure more orders. We do not expect such unexampled altruism from our workmen, but they may, nevertheless, take to heart the principle which such a sacrifice involved.

A WORLD-WIDE STEEL SYNDICATE.

AT the present time there are three matters which tend to show that a certain amount of progress is being made in connection with the grand scheme for the establishment of an international steel syndicate to embrace the principal producing and exporting countries in the world. The first relates to the conventions which have already been concluded, the second concerns the negotiations in progress for arriving at further agreements, and the third refers to the rumours in circulation as to the intentions of interested producers. The important fact for the moment is that the United States Steel Trust, supported by the large exports from that country this year, and also by the slightly improved condition of the home market, has emerged from the shell into which it retired last April, when failure proved to be the only result of the negotiations which then took place in London between representatives of the American, British, and German works for the purpose of concluding an international agreement for the removal of competition, the delimitation of markets, and the settlement of uniform prices. It is uncertain whether the initiative in the matter on the present occasion has been taken by the United States Steel Corporation or its exporting company, or whether it is due to the German Steel Syndicate; but this particular question is quite immaterial, because the American works constitute a factor which cannot be left out of consideration in any arrangements made with the object of dividing the trade of the world in regard to certain products of the steel industry. This fact has doubtless been recognised by both parties; and representatives of the United States Steel Trust and of the German Steel Syndicate have met in conference both in London and Westphalia for the purpose of discussing the situation of affairs.

The primary question from a steel export standpoint relates to the demand for rails in different parts of the world. On this point, but excluding the American works, the British, German, Belgian, and French rail producers have entered into agreements, which are understood to have now been finally ratified and to be in operation. It is, however, necessary, in order to render the rail convention effective, to bring within its scope the United States Steel Products Export Company, which is the export department of the United States Steel Corporation; and it is believed that the inclusion of the Americans is in a fair way of accomplishment as a result of the conferences to which reference has already been made. But for the moment it cannot be definitely asserted that the United States Export Company has become a party to the convention. It must be remembered that the agreements between the four contracting parties apportion a fixed allotment of the world's export trade in rails to the British, the German, the Belgian, and the French works, as stated in a previous issue of this journal. It therefore follows that, having divided up the export trade in this manner, any allotment made to the American Steel Trust or its agencies must cause a displacement of the percentages granted to British producers, who have secured slightly over one-half of the aggregate exports, the German Steel Syndicate, and the Belgian and French rail exporters. A second agreement which has been brought about refers to the exports of girders, joists, and other shapes. This has been arranged between the German Steel Syndicate, the Belgian producers, and the few French works which undertake to deliver out of the country in this particular branch. The British rolling mills, which are not particularly concerned in the exportation of shapes, are, therefore, not included in the Joist Convention, as this combination is termed. Thus it may happen that the same British rail producers who are in agreement with the continental triumvirate in regard to rails will probably find their interests clash with at least two of the trio in respect of the joist market in Great Britain. If, then, the former stand to gain from the rail department, what will they lose from regulated competition in shapes in the British home markets?

Passing over for the moment the question of semi-finished steel products, we reach another of importance to the manufacturers in Great Britain, namely, the production of rolled tubes. Months ago—in April and May last—conferences took place, both in London and Berlin, of representatives of the American Tube Trust, the principal British producers, and the German Gas and Boiler Tube Syndicate, with a view to an understanding being reached in regard to the export trade in tubes. The conferences, however, led to no practical result; but it is now stated on good authority that the representatives of the American Steel Trust on behalf of the Tube Trust, and the representatives of the German Steel Syndicate on behalf of the Gas and Boiler Syndicate, have arrived at an agreement. This provides for the withdrawal on the one hand, of American competition in tubes in Germany, which is a fairly large business, and on the other, for the retirement of Teutonic works from the markets in Mexico and Canada. In addition to this, proposals are said to be on foot for a general export agreement between the German Steel Syndicate, and the United States Steel Corporation, which is reported to have made peace with the Lackawanna Steel Company, a concern of considerable importance from the competitive point of view.

The only certainties in the direction of an international steel trust are, for the present, at all events, and regarded from the British aspect, the formation of rail and joist syndicates, although the works in Great Britain have the prospect of financial advantage from the operation of the rail convention, only provided that affairs are arranged to the satisfaction of the export agency of the United States Steel Corporation. In all other respects in the iron and steel industry, British producers—if we accept the joist syndicate as an accomplished fact, the semi-finished steel products combination as a matter of the immediate future, and the American-German Tube Convention as having actually been concluded, to say nothing of a general export agreement between the latter two parties—are practically left out of consideration. Against tariff-fed or dumped partly manufactured steel products from Germany little can be done at the present time, as the question is or has been one of see-saw between that country and the United States in relation to Great Britain. In the case of Belgium, which has only a moderate import tariff, the question of dumping in England does not come directly into consideration; but it occasionally arises indirectly partly from the operation of works at cost price or at a loss, or from the sales of manufactured products rolled from semi-finished materials purchased from Germany and France at dumping prices; yet in regard to tubes, in which British works are vitally interested, they are said to have been passed over or ignored by the American and German works! Under all the circumstances it really seems as if the British steel works, or at all events those engaged in the production of rails, have sold or are selling their birthright. To make an arrangement in regard to one product, and to allow other export branches to escape, certainly seems foolish, while it allows of the home market being bombarded in other respects, and the sooner the British works begin to act in harmony with each other and sink any individual differences, the better it should be for them as a whole. It is surely not the duty of the pioneer country to collect the crumbs which fall from the table of its pupils.

ELECTRIC MAIN LINE RAILWAYS.

THE electric railway about which we write must not be confounded with the glorified tramway represented by such lines as the Liverpool and Southport or the Metropolitan. We do not mean to disparage the value of these railways; but we have in mind a great main line express passenger service, involving continuous running at or about an average of 60 miles an hour for two or three hours. Running, in fact, like that of the long-distance expresses on the Great Western and other railways in this and various countries. Although at first sight it may seem that constructive details which will suit one class of service will equally well suit another, yet in practice it is not so. The conditions of working play a very important part in the method to be adopted, and it is with these conditions and their influence that we now propose to deal.

On suburban railways the trains stop and start at frequent intervals, and the essential qualification of the motors is great torque, or what is the same thing, great power of acceleration. The motors are worked under constantly varying conditions. At one time a motor will be called on to develop 120 horse-power for perhaps thirty seconds, then the power will drop to 50 horses for a minute and a-half, then to nothing for a minute, and again it will once more rise to a maximum. Now, within a certain very wide range, it may be said that the only limit to the work which a motor can do is its rise in temperature. Practice has shown that the suburban motor is less liable to overheating than one kept continually at work. For a large portion of its time it is running much under its full capacity, for another it is not working at all; and if the train stands at each end of its run for a few minutes cooling down can take place. Recently a paper of a very practical character was read before the Rugby Engineering Society by Mr. Carter, of the British Thomson-Houston Company, in which he dealt with high-speed electric railway work. He showed that if a motor runs for half an hour and then is at rest at a terminus for 15 minutes, it is possible to work with motor losses which are one and a-half times as much as would be possible if the motor ran continuously. That is to say, heat is got rid of which would otherwise be mischievous. When long runs are to be made, the motor must have proportions which are quite different from those which will satisfy frequent-stop, short-run conditions. There is no more reason why a motor should not run cool for a day or a week than there is to prevent a dynamo from doing so. But then the motor must be run at far below the maximum power which it is able to put out for a short time; and the fact at once introduces some important differences between the rolling stocks of the two systems. Electrical engineers like Mr. Carter, who have carefully studied the whole question, hold that for main line express traffic, motors must in the first place, be designed to suit the service, and then the vehicles must be made to suit the motors. One of the results of this appears to be that the motor train cannot be used, and that the power must be carried in a locomotive. This seems to be also the opinion in the United States, if we are to judge by the 90-ton electrical locomotive for the New York Central Railway which we illustrated two weeks ago.

The working of trains by electricity has passed out of the scientific experimental stage, and has entered the commercial experimental stage, and no doubt very much may be found to turn on the question whether a motor train is possible, or an electric locomotive essential. At first sight it seems that if a locomotive weighing 90 tons, or anything near that, must be used, the boasted advantages of electricity as a motive power are lost. It may be shown that to work a train of only five coaches, weighing 125 tons, at 75 miles an hour, at least 50 tons of motor would be required; and it is open to question whether the 2500 rated horse-power could not, on the whole, be better carried in a locomotive than in the coaches. It is well to remember that the Zossen single coach weighed no less than 83 tons; of course, the speed was abnormal; but when we come to add a dozen tons or so of motors to a coach, the coach itself must be strengthened, at least so far as the framing is concerned, and so the weight becomes cumulative. Under the circumstances it is not very easy to see where the advantage comes in. If we estimate the cost of power in terms of fuel burned, it will probably come out about two to one against electricity. Of the capital cost it is not necessary to speak; we are considering running expenses only. No one, so far as we are aware, indeed, has claimed for electricity that it will enable fast passenger traffic to be conducted at less cost than now obtains. We might, perhaps, say that the expense of the system is so well known that no one seriously advocates its adoption. This would be going too far, however, and the electrical working of long-distance passenger trains is recognised as by no means outside the region of profitable discussion. The paramount claim which electricity makes on the attention of railway men is that it places at their disposal an amount of tractive effort which cannot be had from any steam locomotive. Thus, for example, Mr. Carter told his hearers that motors "running free," that is to say, not accelerating a train, which exerted about 625 horse-power, could for a limited period give out 2500 horse-power. This is more than could be hoped for from a steam locomotive. But after all, is it quite necessary that a power so great should be provided? It matters nothing whether 30 seconds or three times that period are required to get a speed of 30 miles an hour when a train has a run of a couple of hours before it. It may very well be asked, Why provide motors of such power? The answer is simply that for continuous running it is not safe to reckon on more than one-fourth of the rated power of the motors. A weight of 160 lb. per horse-power seems to be about the least allowable with closed-in motors mounted on the coach bogies, but a motor may for a short time develop a horse-power for 40 lb.

If, however, a locomotive is used, methods of cooling by ventilation at once become possible, and inasmuch as the problem of problems about long-distance electric railway runs turns on preventing the motors from getting hotter than about 170 deg. Fah., it seems that while the motor train is in all ways the best for a suburban service with light rolling stock, high acceleration, and many stops, the locomotive will be found to possess overwhelming advantages for main line long run express passenger trains weighing 250 to 350 tons. In

Mr. Carter's words:—"We shall use locomotives rather than mount the motors on the train axles. This implies the abandonment of the multiple unit train control system; but as the advantages of this system are needed chiefly in suburban service, this point is of small importance for the class of service we are considering. The motors will be large and powerful units, probably open on the cab side to aid the dissipation of wasted energy, but closed to the weather. The usual method of rating, which was developed to suit the needs of tramway motors, will probably be abandoned in favour of some method more suited to the service that these motors will be called upon to perform. The tramway type of motor, in conquering the suburban railway field, has probably reached the limit of its usefulness in railway work, and for main line service we should expect motors differing largely from those we are accustomed to."

It may be asked whether under these conditions it is likely that electricity will supersede the steam locomotive for this class of work. So far as the facts are known, there is nothing to be advanced in favour of electricity. The peculiar advantages which it possesses over the steam engine are just those which are not wanted for long-run traffic. But it is not expedient to prophesy, and it is even conceivable that a system of construction and a method of working may be possible which would give better results than any to be had at this moment. The small unit system may be mentioned, in which numerous separate one or at most two-vehicle trains would take the place of the present huge corridor train. All this is, however, somewhat beside our desire to call attention to a few of the questions which arise when the hauling of ordinary passenger trains by electricity instead of steam is contemplated.

RIGHTS OF PROPERTY IN DRAWINGS.

THE case of Estler Brothers *v.* J. Tylor and Sons, Limited, which was heard by Mr. Justice Farwell, recently, raised certain points of great interest to engineers. The plaintiffs carry on business as electrical engineers and manufacturers of electric traction material. The defendants were sanitary engineers and brass and iron founders. In October, 1900, the defendants undertook to manufacture for the plaintiffs certain castings, fittings, and electrical appliances from designs consisting of drawings, tracings, photographs, patterns and samples supplied by the plaintiffs. The castings, &c., so supplied were to be sold by the plaintiffs in the ordinary course of their business. The plaintiffs allege that it was an express, or in the alternation that it was an implied term of the contract, that the defendants would not make use of the patterns or drawings, except for the purpose of fulfilling the plaintiffs' orders. The defendants, however, made for their own purposes, and advertised for sale fittings, castings, and appliances which were, in all material respects, reproductions of the fittings, castings, and appliances made by them for the plaintiffs from the plaintiffs' designs and patterns. The plaintiffs accordingly claimed an injunction to restrain them from continuing this course of conduct. The defendants, by way of defence to the action, alleged that the fittings and castings made by them were common to the trade. They also alleged that they were entitled to do what they did by a custom of the trade. This plea was withdrawn. At the conclusion of the plaintiffs' case, and when the defendants had called some witnesses, it was announced that they no longer desired to contest the action. Their counsel said:—"The defendants were honestly mistaken in thinking that all the fittings and appliances which they had advertised for sale were common to the trade. It has been made clear that some of them are not. This being so, my clients will submit to an injunction restraining them from using any of the plaintiffs' designs or manufacturing according to them." It seems clear, from the facts of the case, that the result would have been the same had it been fought out to a finish. It is reasonably clear that when a man forwards a drawing to be carried into execution by a manufacturer he does not thereby authorise the manufacturer to make further use of the drawing for his own benefit. The case under notice is useful, inasmuch as it makes the law upon the subject absolutely clear. With regard to drawings, however, other points sometimes arise which are not affected by this case. Suppose an engineer is employed to design a bridge, and the bridge is eventually completed in accordance with the designs. Who can claim the designs? Attempts have been made from time to time to show that, in the parallel case of an architect, the architect is entitled to plans, and an alleged trade custom has been prayed in aid of this rule but without avail. In a recent case which came before the divisional court it was held that the plans become the absolute property of the building owner, who can do with them what he will. It is conceived that, upon the authority of this case, the person upon whose orders an engineer makes plans and drawings for a bridge has an absolute property in those plans and drawings, and may build as many bridges as he chooses in accordance therewith.

WORKSHOPS AT SEA.

ON the 15th inst. tenders were opened for the construction of two cruisers, North Carolina and Montana, and one battleship, the New Hampshire, for the United States Navy. The results of the competition are not yet made public in this country. No details of the battleship have been published. The cruisers will be 502ft. long, 78ft. beam, and on a draught of 25ft. will displace 14,500 tons. The armament of the cruisers will consist of a main battery of 4 10in. and 16 6in. breech-loading rifles, 23 3in. rapid fire guns, and 4 submerged torpedo tubes, and a secondary battery of 12 3-pounder and 4 1-pounder semi-automatic guns. The propelling plant will include engines of the vertical, twin-screw, four-cylinder, triple-expansion type, of a combined indicated horse-power of not less than 23,000, and 16 water-tube boilers of a type to be approved by the Bureau of Steam Engineering. A novelty consists in the installation of very complete workshops on board. All warships carry appliances for making small repairs. But hitherto it has been the practice of fleets to rely mainly on floating factory ships such as our own Vulcan. The new cruisers are intended to be self-sufficing to a large extent. The list of machine tools to be placed on board represents plant sufficient for a nice little works on land. Thus, for example, there is to be a gap lathe, to swing 48in., a 14in. screw-cutting lathe, universal milling machines, grinders, and powerful drilling machines, to say nothing of a fairly complete blacksmith's forge. The precedent established seems to be worth following. The provision of facilities for making repairs thus provided cannot fail to play an important part in keeping a ship in a high degree of efficiency.

THE RAILWAY COAL CONTRACTS.

THE interest in regard to the placing of these important contracts has in no way abated. As stated last week, the South Yorkshire coalowners sent in tenders at 8s. 6d. per ton, and, it is said, are fairly unanimous in holding out for the price named. Up to Wednesday evening none of the companies, save the Lancashire and Yorkshire, had approached the coalowners. As in other years, they are evidently looking out for some change. It is stated that the Lancashire and Yorkshire has during the week made overtures to a number of the South Yorkshire thick seam coalowners with an offer of 8s. per ton. The offer, it is stated has been declined, but it is admitted that the company has been successful in placing a portion of its contract at 8s. per ton with a firm in the Barnsley district working a thinner seam of coal. Last year the company went further afield, and placed a considerable portion of its contracts in the Wath and Mexborough districts at 8s. 3d. per ton. The contracts for the supply of fuel to the Grimsby and Hull fishing fleets are also in the market, and seem likely to create a good deal of competition. These contracts have of late assumed considerable dimensions. So far as is known, the gas contracts placed in the South Yorkshire district have been taken at a slight reduction on the price paid for coal under expiring contracts. The local railway traffic is likely to be disturbed by the fact that one large South Yorkshire firm has obtained an order for 40,000 tons of gas coal for the Belfast Gas Company, which last year was obtained by a firm in another part of the coalfield.

THE DEFENCES OF OUR GREAT NAVAL PORTS.

AN important change is now in progress as to the nature and appliances of most of the armament at present comprising the fixed defences of our great naval ports—nay, indeed, this change has already been put in hand with considerable vigour under the supervision of the Defence Committee at the War-office.

It is true that, as changes in the nature of guns, their mountings, gun positions, and other appliances took place, a limited—may we not say a very limited—number of the improved weapons has for some years taken the place of the antiquated armament which was laid down so early as 1874, the approximate period when the scheme for the arming of our coast defences was taken in hand seriously. Here and there we find some excellent and powerful guns mounted, such as 10in., 9·2in. and 6in. of the most recent mark, and it is impossible to find fault, either with such weapons themselves or with the capital emplacements in which they are mounted. But they are a mere handful when compared with the vast number of clumsy old muzzle-loaders and very early breech-loaders which still encumber the coast batteries of Great Britain and Ireland.

In 1874 about 800 heavy muzzle-loading guns were appropriated to the various coast positions, including the four great naval ports, also Portland, Dover, the Bristol Channel, Cork Harbour, the Forth, &c. &c.; and at the present moment far the larger proportion of these positions, and many others equally important, possess very few recent weapon. Here and there the old monstrosities have been got rid of entirely, a considerable number having been ignominiously buried in the ground in the vicinity of the forts which contained them, as they were not worth the cost of transport to Woolwich Arsenal; and, as we said before, they have been replaced with admirable guns. But the re-armament has not hitherto been carried out on a comprehensive scale.

Now we understand that the matter is being taken vigorously in hand, and that large bodies of Garrison Artillerymen are at work removing the 12½in. muzzle-loading guns of 38 tons, the 10in. muzzle-loading guns of 18 tons, and others of a smaller calibre and weight, from the various coast batteries and forts, a considerable number of 6in. quick-firing guns and a smaller proportion of 9·2in. guns, all of the latest mark for land service, having been manufactured and appropriated to fill the vacant gun positions. The work of removal is very heavy, and the change involves a good deal of alteration of the gun ports and other features of the emplacements; but the position-finders have been already fixed and position-finding cells constructed for the various groups of guns, two generally forming a group, so that part of the recent work done will not have been in vain.

But the artillery authorities are not intending to open out with any more obsolete appliances. Their programme is a very ambitious one. Recognising the immense importance of electric power and its great simplicity of action, they are, we are told, fitting the new guns of a quick-firing nature with electric motors for training and elevation, a small circular motor being affixed to the sprocket wheels and spindles, which will run the gun from one end to the other of its arc of training in a few seconds, and elevate or depress it with equal celerity and ease. In the event of any untoward circumstance putting the electric motor out of action, the gear can be detached in a moment by a simple movement, and ordinary hand wheels be employed for both training and elevation. With the old muzzle-loading guns in casemates, the port lintels were so low that the size of the chase prevented the gun being elevated to a reasonably high angle, involving a very short and almost ineffective range. With the new weapons and a little modification of the lintels the range is vastly increased. As we said before, the same position-finders and position-finding cells will be utilised for the new guns, only the surface of the plane table, upon which the pencil pointer of the arm of the position-finder travels, will be much extended in a line with the axis of the instrument, as the guns will have, of course, a much longer range.

The necessity for putting our coast defences into a thoroughly efficient and up-to-date condition is obvious. Opinions differ as to the value of such defences, but there can be no doubt that if we have them at all they ought to be the best of their kind. That they are not so now is not in any measure due to the apathy or indifference of the authorities concerned. The Navy is, and must always be, by far the most important element in the defence of our coasts and great naval ports. So great has been the prejudice of the nation against any serious development of the system of permanent fortification, that the expenditure necessary for securing a reasonable amount of shore battery protection has only been possible by putting it down to Naval votes, which has been the practice for years. This is absurd; land services should appear in Army votes, as the batteries will be manned by shore gunners.

DOCKYARD NOTES.

THE new training squadron will be composed as follows:—St. George, Isis, Gibraltar, Hawke, and Highflyer—the latter carrying naval cadets.

IT is rumoured that the reconstructed Mediterranean fleet will consist of the two Queen class, three Formidables, three Londons, and the Vengeance. All the Duncan class will go to the new Atlantic fleet, according to service gossip, also the Swiftsure and Triumph. Another rumour places these ships all in the Home Squadron. Probably the detail is yet unsettled, but it is apparently established that so far as possible all squadrons will be homogeneous and contain all the ships of any particular type. This is as it should be. Duncans mixed with Londons are wasted, and their speed superiority of no avail. They become transformed into weak Londons.

STERN submerged tubes are to be fitted to the King Edward VII. and her sisters. As originally designed, she, the Dominion, and the Commonwealth, were without stern tubes.

THE old unprotected cruiser Iris has been put out of commission as a training ship, the Gibraltar replacing her.

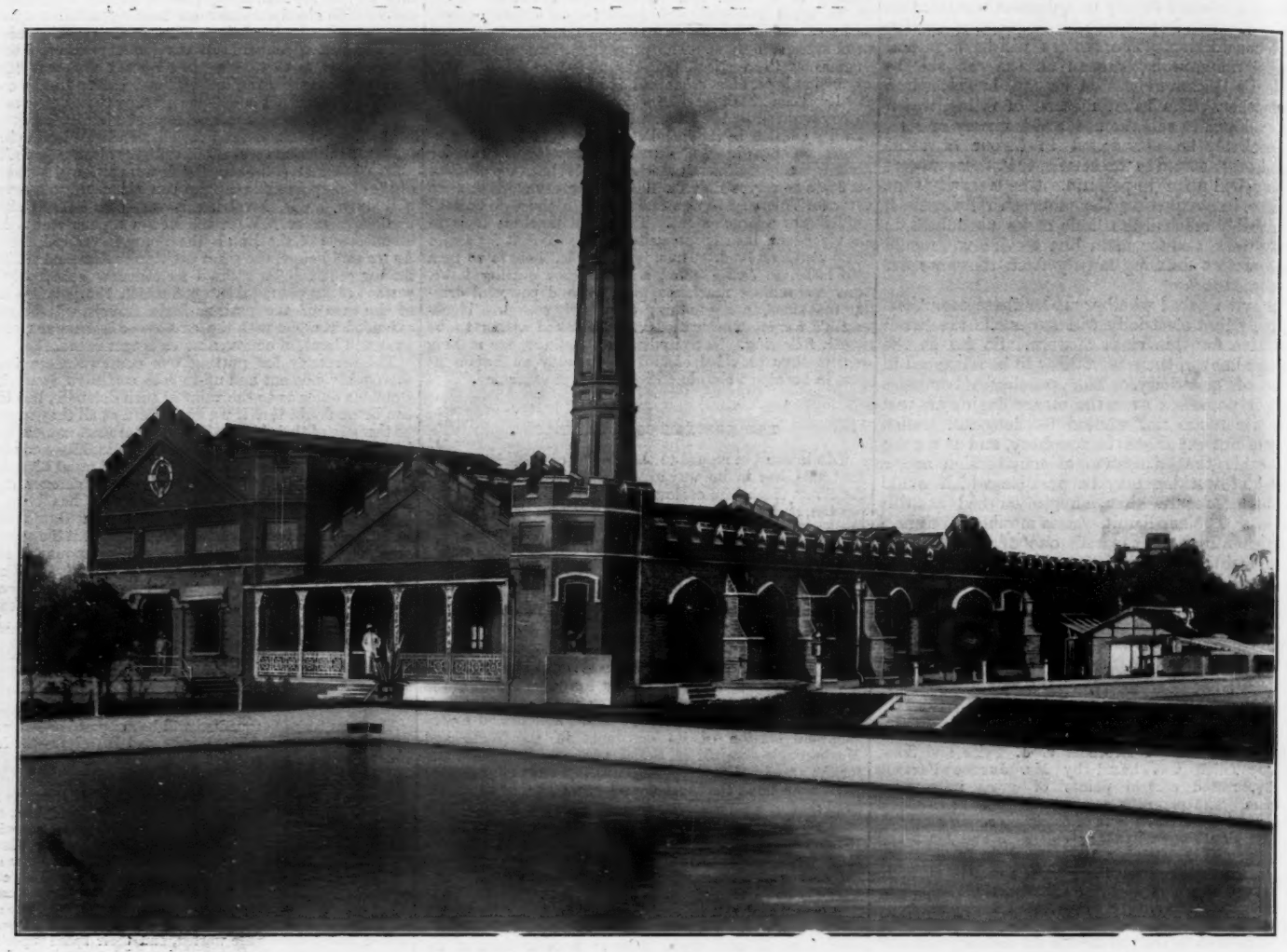
A GREAT sale of warships takes place next spring at one or other of the dockyards; three battleships and no less than thirty cruisers will be sold off. The armada thus to be disposed of is understood to be composed as follows:—Battleships: Dreadnought, Sultan, Monarch—now Simoon. Cruisers: Medea, Medusa, Ringarooma, Pallas, Pearl, Psyche, Marathon, Melpomene, Magicienne, Pandora, Iris, Mercury, Archer, Porpoise, Brisk, Calliope, Cleopatra, Northampton, Barracouta, Barrosa, Blanche, Blonde, Philomel, Mildura, Katomba, Tauranga, Wallaroo, Pomone, Pactolus, and Scylla. One modern cruiser could probably "take on" the lot.

THE Apollo class are going to be distributed as drill ships for Naval Reserves and Naval Volunteers; the balance left over are likely to be on the market ere many months have sped. The Brilliant has already been utilised for the Royal Naval Reserve.

THE Russian Captain Klado, who ever since the Dogger Bank affair has been a celebrated figure in Russia, seems to have demanded his "third squadron" without much asking where it is to come from. Apart from the Dardanelles question, it is doubtful whether a single Black Sea ship is effective enough to go, while in the north there remains nothing but the three little ships of the Apraksin class.

FOUR THOUSAND MILES MOTOR CAR TRIAL.—The 16-20 horse-power Martini motor car completed its 4000 miles trial on December 7th under ordinary touring conditions. The daily run consisted of a maximum of 200 miles per day on main roads, starting from and returning to the Automobile Club, where the car was locked up each night, after washing, lubricating, replenishing, and making adjustments. The weather throughout the test was very severe, but only nine involuntary stops, irrespective of tire troubles, were made, three being due to chain failures, two to thaw the oil in the lubricator, one on account of the differential gear being stripped, and one caused by the choking of the petrol jet. Over four hours were occupied in tire troubles on the road, and new covers and inner tubes had to be provided. The number of days occupied was twenty-two; the total consumption of petrol, 245½ gallons; the total consumption of water, 3·9 gallons; the average daily mileage, 181·8; the average mileage per gallon of petrol, 16·3; and average mileage per gallon of water, 1015. The roads throughout the trial were somewhat heavy and greasy, and there was much fog. Rain and snow and numbers of loose patches of stones were encountered. On the fourth day a bad side-slip occurred, the near hind wheel hitting the kerb hard and slightly displacing the rim. This caused the tire to chafe on the head of the chain bolt. A new wheel and tire were fitted at the end of the day's run. Three other side-slips also occurred. The car was fitted with low-tension magneto ignition.

ENGINE AND BOILER HOUSE, SHANGHAI WATERWORKS



SHANGHAI WATERWORKS.

In a two-page Supplement, and on this and the next page we give views of the pumping-station of the Shanghai Waterworks Company and of an excellent set of pumping engines which have recently been installed there. The Shanghai Waterworks were the first to be constructed either in China or Japan. Shanghai is situated on the Hwang-Poo, about 14 miles from the Woosung Bar, at the entrance of the river. The Hwang-Poo derives its chief supply from the Yang-Tsze-Kiang. The original works included a water tower, containing a reserve of 150,000 gallons, at an elevation of 103ft. 6in. from the centre of the water main supplying it to the top water level. This tower was erected because the nearest high land suitable for constructing a reservoir is fully 20 miles away and quite inaccessible. Moreover, such a reservoir would have had to be placed beyond the limits of the concession granted by the Chinese Government. The tank is 50ft. in diameter, 12ft. 3in. deep, and contains 670 tons of water. It is made of boiler plate, the floor being $\frac{3}{8}$in. thick and the sides from $\frac{1}{2}$in. to $\frac{7}{16}$in. thick. A 20in. main was at first laid from the pumping station to the water tower.

The water used is taken from the river. The original scheme included two settling reservoirs with an exposed water surface of 75,000 square feet collectively. Sedimentation before filtration was an absolute necessity, owing to the turbid condition of the river. Each reservoir was 250ft. by 150ft. and 13½ft. deep. The total capacity was 6,130,312 gallons. Arrangements were also made for a third reservoir, which was designed to hold 2,762,500 gallons. The reservoirs were constructed on the foreshore of the river, with their floors placed 4ft. below low-water mark. There was a service tank for filling the filter beds, this tank being 220ft. long by 92ft. wide and 8ft. 6in. deep. It contained 996,000 gallons of water. From this the water was originally led to four filter beds, having a total surface of 4266·5 square yards. Provision was made for constructing four further filter beds when they should be required. Each was designed to filter 30,000 gallons an hour, and all were 120ft. by 80ft. by 9ft. 6in. deep, with 5ft. 6in. of filtering materials. The average rate of percolation permitted was 540 gallons of water per square yard per twenty-four hours. There was, further, a service water reservoir of 840,000 gallons capacity, 120ft. by 80ft. by 14ft. deep to full-water level.

The original pumping machinery consisted of two horizontal compound pumping engines, one set of the rotative type and the other of Davey's differential type. Each engine was designed to deliver into the water tower 75,000 gallons per hour. Two sets of duplicate centrifugal pumping engines, each capable of delivering 105,000 gallons of water per hour, were installed to raise the water from the high-level service tank, which acts as a subsidiary settling reservoir and feeds the filter beds. Independently, there was also a second set of centrifugal pumping engines, each capable of raising 190,000 gallons of water per hour into the service tank from the settling reservoirs.

Recently it was decided to install the plant which forms the subject of the present article.

The contract for this set of pumping engines included the erecting and setting to work at Shanghai of a cross-compound condensing horizontal engine, with double sets of pumps, steam receiver and re-heater, barring engine, air vessel, floor plates, girders, stages, rails, balusters, and all other apparatus, attachments, appliances, and connections, to make the engines and pumps complete. It was secured by Manlove, Alliott and Co., Limited, Broomsgrove Works, Nottingham.

The high and low-pressure cylinders, 32in. and 52in. diameter, are placed side by side upon separate bed-plates, working direct to a crank shaft, with cranks 90 deg. apart, and with the fly-wheel between the two cranks. Each piston-rod passes through the back cover of its cylinder, and is continued so as to drive a horizontal double-acting plunger pump attached to the engine bed-plate. The stroke of both engines and pumps is 4ft.

The engine pumps six million gallons of water per twenty-four hours, and delivers the water directly into a high service tank through mains 2¼ miles in length.

The steam pressure in the boilers is 80 lb., and the proportions of the cylinders are arranged as nearly as possible to secure an equal division of the work between the two cylinders.

The strength of the low-pressure engine is such that it may safely receive the full steam pressure of 80 lb. should this ever come upon it, and the parts of the engines generally are designed so that they will not rupture under ten times the calculated stress.

Both cylinders are steam jacketed, and the jacket space round the high-pressure cylinder is 2in., while that round the low-pressure cylinder is 1½in. The cylinders were bored out in a horizontal position. The circulation in the jackets as well as in the steam tubes of the re-heater receiver are made in a closed circuit; the whole of the condensed water in the jackets being collected into a receiving vessel, and returned to the boilers by means of an auxiliary pump and main. The ports and passages are so arranged that they will drain into the eduction pipe. Relief valves are fixed at each end of the high-pressure cylinder. The cylinder covers are designed with substantial ribs, and finished bright on all the plain surfaces and edges. They are also steam jacketed.

A re-heater receiver is placed between the high and low-pressure cylinders, of suitable volume to permit of a sufficient range of cut-off in the low-pressure cylinder, without causing excessive or rapid rise of back pressure in the high-pressure cylinder. The tubes in the receiver are surrounded by the exhaust steam from the high-pressure cylinder on its passage to the low-pressure cylinder, live steam direct from the boiler being admitted to the interior of the tubes.

Great care has been taken to arrange the passages to and from the receiver so that the working steam will circulate completely from end to end of the receiver, and remain in contact with the tube-heating surface as long as possible. Thermometers are provided and fixed in specially-prepared pockets to show the temperature of the steam as it passes to and from the re-heater. The whole of the cylinders, receiver, passages, and the steam main in the engine-room, after being covered with composition, have been lagged with planished sheet steel, secured by bright brass bands. The lagging has been carefully fitted and arranged in sections, so that any one section can be removed without disturbing the others.

A highly sensitive and powerful Porter balanced governor, with levers, rocking shaft, and coupling-rods, has been provided and coupled up to the cut-off, for controlling the speed of the engine. The governor has been arranged with a suitable oil cataract cylinder for the prevention of unsteadiness, the cylinder being fitted with two adjustable valves for controlling the passage of the oil. A special speed adjuster is fitted, by which the revolutions of the engine can be varied within wide limits.

The steam and exhaust valves of both cylinders are of the Corliss type, the steam valves all being tripped and arranged to cut-off from zero to five-eighths of the stroke; those of the high-pressure cylinder being automatically controlled by the governor, and those of the low-pressure cylinder being adjustable by a hand wheel, and having an index to show the point of cut-off.

Arrangements are also made on the high-pressure cylinder valve gear, so that, should the speed of the engine vary abnormally from the mean speed, the steam valves are thrown out of action and left in a position covering the steam inlet ports, completely shutting off steam, and at the same time automatically opening a valve on the condenser and instantly destroying the vacuum. Each valve can be separately and independently set and adjusted with precision, without disconnecting any of the gear or removing any part of it. The amount of valve motion is reduced by the introduction of of what is known as the "lost arc" movement.

The fly-wheel is 16ft. in diameter, formed in four sections, and is of sufficient weight to keep the motion of the engine uniform when its speed has been reduced to twelve revolutions. The rim of the wheel is turned, and teeth are cast on one side of the periphery for engaging with the pinion on the barring engine. The barring engine provided has sufficient power to move the engine when the pumps have their full load on them.

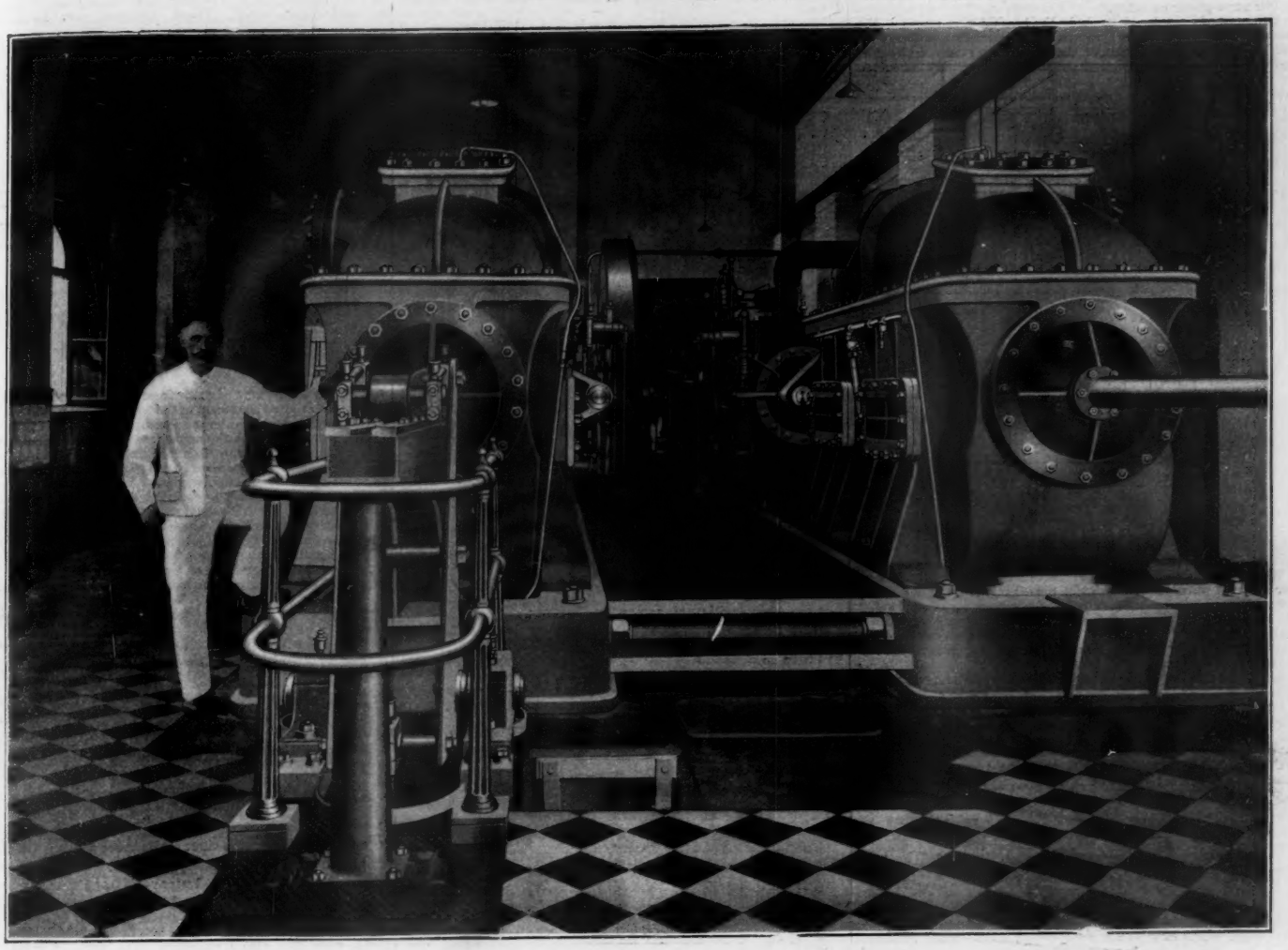
Both pumps are of similar design, and each has a separate suction 22in. bore. The delivery pipes from the pump are 21in. in diameter, leading to a 24in. common delivery through the condenser to the air vessel. The pumps are horizontal, of the multiple valve type, with plungers having gun-metal rings working in sleeves attached to diaphragms in the centres of the pump bodies. The illustrations show that access doors are placed in suitable positions to get easily at both suction and delivery valves for removal or repair. The suction and delivery valves are of uniform pattern, and arranged so that each valve can be removed separately.

A reflux valve, with gun-metal faces, is fixed in the delivery pipe. The air vessel has fully twelve times the capacity of one double-acting pump. A by-pass valve is attached to the pump delivery, and is sufficiently large to pass the whole discharge from the pumps. The pipe from it leads the water back into the suction tank. A deadweight safety valve, large enough to pass the whole discharge from the pumps, is also fitted on the delivery side. A separate air-charging engine and pump is fixed for charging the air vessel, and is powerful enough to half fill the air vessel with air at working pressure in thirty minutes.

The surface condenser is of ordinary construction, with solid drawn brass tubes, gun-metal tube plates, and stay rods. The exhaust passes through the tubes, with the cold

SHANGHAI WATERWORKS—PUMPS

MANLOVE, ALLIOTT AND CO., LIMITED, NOTTINGHAM, ENGINEERS



water outside, the ends of the condenser body being arranged so as to be easily removable for the purpose of cleaning the tubes. An injection cock is also fixed in connection with the condenser and the pump main, so that injection condensation may be available.

A feed-water heater is fixed above the condenser in connection with it and the eduction pipe. This feed-water heater has brass tubes of sufficient area and number not to impede the passage of the steam to the condenser. The exhaust steam passes through the tubes, with the feed-water on the outside. A feed pump, with a 3in. main, places the feed heater on the circuit of the feed main between the pump and the boilers. An Edwards patent air pump is fixed in connection with the condenser, and is worked by bell-crank levers, actuated by the tail rod of the main pump, which is driven by the low-pressure cylinder.

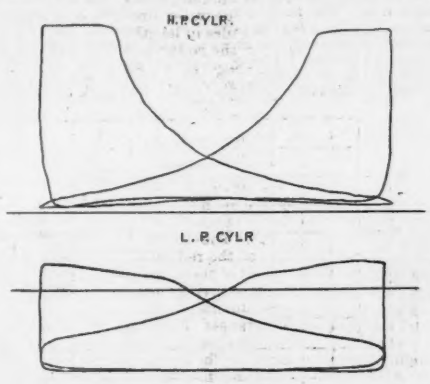
Cast iron girders are arranged as required to carry the various parts, and the girders and sole plates are machined where they are in contact with one another and with other parts of the machinery. All parts of the machinery below the floor level are in properly formed pits, covered with movable cast iron chequered plates. Brass hand railing, with massive polished balusters, is carried entirely round the crank end of the engine and fly-wheel, and also round the air-pump motion work. All the rods of the engines and pumps work through stuffing-boxes and glands fitted with metallic packing. The lubricators are all of modern design. There is the usual complement of gauges, counters, &c., and the contract included the steam piping and accessories required to connect to two existing Lancashire boilers. It was stipulated that the castings were to be equal to a stress of at least 7 tons on the square inch of section, or their transverse strength was to be such that they would be capable of sustaining for twenty-four consecutive hours a weight of 30 cwt. placed in the middle of a length of bar 1in. wide by 2in. deep, supported on points 3ft. apart. The wrought iron has a tensile strain of above 20 tons on the square inch, and where steel is substituted for wrought iron the dimensions are not reduced.

The makers of the engine guaranteed that when the engine was performing the specified duty the consumption of best Welsh coal should not exceed 2 lb. per water horse-power per hour, 1 lb. of coal to be equal to an evaporation of 10 lb. of water; and, in order to ascertain such consumption of coal, a trial of the engine was made by the executive engineer for twenty-four consecutive hours under the following conditions:—

"The engine to pump under the head of the high-service tank. The actual horse-power developed by the engine during the coal trial to be arrived at as follows:—Measurements every fifteen minutes shall be made from the engine-house floor level to the surface of the water in the suction well, the average of such measurements being taken as the depth to the water in the suction well; and, at the same intervals of time, readings of the pressure on the pumping main—the zero of such readings being the engine-house floor level—shall be taken, the average of such readings being deemed to be the main pressure in the pumping main; and this, added to the distance of the engine-room floor to the water level, shall be taken as the entire head against which the pumps shall have been worked. The quantity of water pumped shall be assumed to be nineteen-twentieths of the capacity of the two pumps multiplied by the number of revolutions made by the engine during the trial."

The actual tests showed that the consumption of water, which was guaranteed not to exceed 20 lb. per pump horse-power, was proved to be 17·84 lb. per pump horse-power per hour. This water consumption represents the total amount supplied to the boilers, and no deductions have been made for safety valves blowing off, steam pipe condensation, &c.

The indicator diagrams reproduced were taken under ordinary working conditions. It will be seen that the distribution of steam is good, and that the power is fairly evenly divided between the two cylinders. The consulting engineers for the Shanghai Waterworks Company, Limited, are Messrs. John



Taylor, Sons, and Santo Crimp, of Westminster; the makers of the pumping engines were Manlove, Alliott and Co., Limited, engineers, Nottingham; while the tests referred to were made in Shanghai by Mr. A. P. Wood, M. Inst. C.E., the chief engineer of the company. We have only to add that the design, material, and performance of this machinery well maintain and enhance the reputation of British engineers abroad.

THE TARIFF COMMISSION.

THE Tariff Commission have held nine meetings during the past three weeks at the Whitehall Rooms, under the chairmanship of Sir Robert Herbert, G.C.B., making eighty-four sittings to date. At the last nine meetings evidence was taken in regard to the engineering, textile, timber, building, granite, slate, cement, glass, brush, pianoforte, and perfumery trades. The witnesses examined in each section were as follows:—

Engineering.—Mr. J. F. Cay, Patent Shaft and Axletree Company, Limited, Wednesbury.

Textile.—Mr. Martin Albrecht, Albrecht and Albrecht, Hudson-road, Burmantofts, Leeds, woollen and worsted merchants, manufacturers, and exporters of clothing.

Timber.—Mr. E. M. Esdaile, Esdaile and Co., Limited, City Sawmills, Wenlock-road, City-road, N., and 227, Old Ford-road, Bow, E.

Building.—Mr. Edwin Seward, F.R.I.B.A., Queen's Chambers, Cardiff, architect and surveyor.

Granite.—Mr. Bernard A. Freeman, John Freeman, Sons and Co., Limited, 7, Victoria-street, London, S.W., granite quarriers and merchants; Mr. Gerald Briggs, Shap Granite and Patent Concrete Company, Limited, Shap, Westmorland, and Ceriog Granite Company, Limited, Chirk, North Wales; Mr. W. H. Newall, D. H. and J. Newall, Dalbeattie Granite Works, Dalbeattie, N.B.; Sir John Mowlem, Bart., John Mowlem and Co., Limited, Grosvenor Wharf, Westminster, London, S.W., and Guernsey, and the Mountsorrel Granite Company, Limited, Mountsorrel, near Loughborough.

Slate.—Mr. J. G. Ashmore, the Oakeley Slate Quarries, Limited, 53, Parliament-street, London, S.W.; Mr. C. Braby, E. and C. Braby, Bangor Wharf, Belvedere-road, London, S.E., slate and marble merchants and manufacturers.

Cement.—Mr. Frederick A. White, the Associated Portland Cement Manufacturers, Limited, Dixon House, 72, Fenchurch-street, London, E.C.; Mr. Charles Charleton, I. C. Johnson and Co., Limited, Greenhithe, Gateshead, and 4, Eastcheap, London, E.C.

Glass.—Mr. A. Dodds, Sowerby's Ellison Glass Works, Limited, Gateshead, secretary Pressed Glass Manufacturers' Association of Great Britain; Mr. L. J. Murray, John Walsh Walsh, Soho and Vesta Glass Works, Birmingham, manufacturers of table glass, fancy glass, and shades for all kinds of lighting.

Brush.—Mr. E. Bailey Page, S. D. Page and Sons, Norwich, London, and Wymondham, brush manufacturers; Mr. Ernest N. Kent, G. B. Kent and Sons, Limited, 75, Farringdon-road, London, E.C., brush makers.

Pianoforte.—Mr. J. Clementi Collard, Collard and Collard, 16, Grosvenor-street, Grosvenor-square, W.; Mr. Henry Billinghurst, director and secretary, and Mr. Thomas Hall, manager of the factory, John Brinsmead and Sons, Limited, 18, 20, and 22, Wigmore-street.

Perfumery.—Mr. C. V. Barrett, Messrs. J. and E. Atkinson, Limited, 24, Old Bond-street, London, W., chairman of the Perfumery Sub-section of the London Chamber of Commerce.

UNIVERSITY OF BIRMINGHAM.—A new Chair of Electrical Engineering has been established in the University of Birmingham as a supplement to the Lectureship in the same subject held by Dr. D. K. Morris. The first occupant of the Chair will be Mr. Gisbert Kapp, now lecturer at Charlottenburg. He is not expected, however, to return to this country until the autumn of next year, and his appointment will not take effect till October, 1905. Meanwhile, and subsequently, Dr. Morris and his staff will continue their work. The new and large buildings for the department will be ready by that time. Professor Burstall will continue to occupy his Chair, the title of which will be changed to "Mechanical Engineering," and he will have control over a great engineering block and the power station. It is not improbable that a special Chair of Civil Engineering in the narrower sense will be established. It is certain that a competent assistant will have to be elected to assist Professor Kapp in the drawing-office for dynamo and central station design.

A BAD CASE OF DISCHARGE OF WATER WITH STEAM FROM WATER-TUBE BOILERS: CAUSE AND REMEDIES.*

By A. BEMENT, Chicago, Ill. (Member of the Society).

THIS is a particularly interesting case, because the trouble existed on a large scale, and the two engines seriously affected were of some 10,000 horse-power capacity.

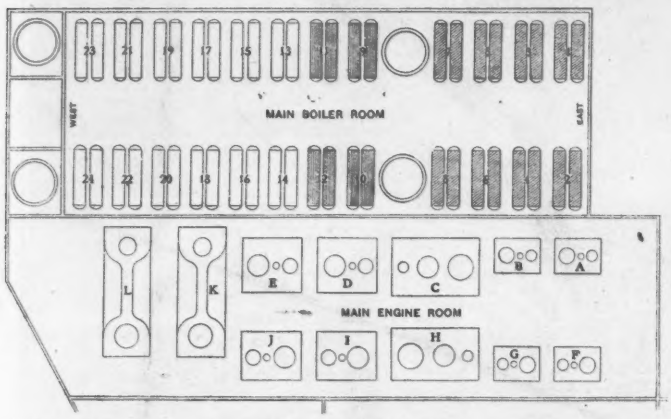
The methods employed to study the trouble were unusual, the most valuable feature of which was the construction of an experimental boiler, a reproduction of the large boilers on a small scale, and provided with a transparent glass steam drum. By this means information was obtained which could not otherwise have been secured.

The most important result of the investigations concerns the performances of water baffles, a device placed in the front end of the steam drums of water-tube boilers, for the purpose of deflecting the water in circulation downward to prevent it being carried out with the steam. It was found that this device, as used in the Heine type of boiler, which discharged the steam from the front end of the drum, could be greatly improved.

Conclusions regarding the utility of separators for removing water from steam is an interesting feature.

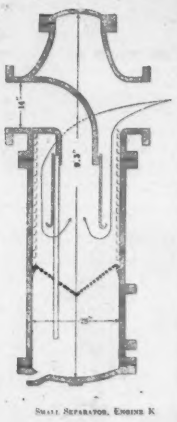
Effect of draughts of steam caused by the flow to engines at the interval of valve opening, is presented in a graphic manner, explaining why the same type of boilers serving smaller engines were not affected enough for discharge of water to be noticed.

The fact was also made evident that the present methods of determining moisture in steam is unreliable, on account of failure to obtain a representative sample. Also, that the tendency is for the sample to show most moisture when flow of steam from the boiler is small, and least when the flow is greatest.



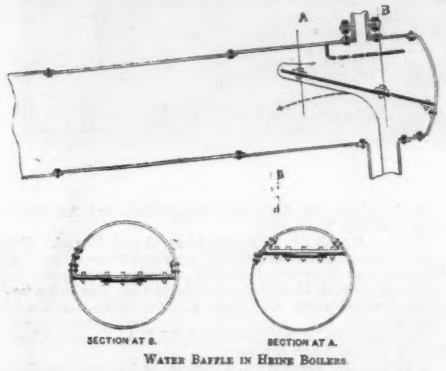
PLAN OF MAIN PORTION OF STATION.

Fig. 1



SMALL SEPARATOR, ENGINE K

Fig. 4



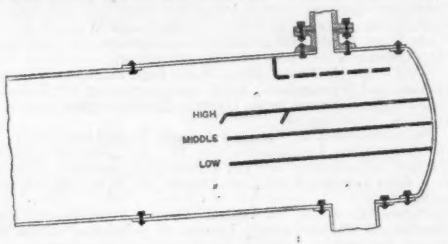
WATER BAFFLE IN HEINE BOILERS.

Fig. 2

DESCRIPTION OF PLANT.

The investigations to be described were made in an electric generating plant of 19,790 kilowatt capacity, of which Fig. 1 is a plan showing the main portion. Boilers Nos. 1 to 24 inclusive are of the same water-tube type; Nos. 2, 4, 6, 8, 10, 12, and 14 of 3800, and the opposite boilers of 4340 square feet of heating surface each; Nos. 15 to 21 are of 4800 square feet of heating surface each. All have two steam drums 42in. diameter by 18ft. long, and are served by a chain grate stoker of an area of 72·2 square feet under each unit.

Engines A to J are vertical triple-expansion direct-connected units, of 440 each for the smaller and 880 kilowatts each for the larger. K is a vertical cross-compound Reynold's Corliss engine direct-connected to a generator of a maximum kilowatt capacity of 4500, and L is a similar unit of 3250 kilowatts. Another portion of the plant adjoining the main engine-room on the side opposite to the main boiler-room, but which is not shown, contains four water-tube boilers of another type of 5000 square feet of heating surface each, and two generating units of 2500 kilowatts capacity each.



STYLE OF BAFFLES.

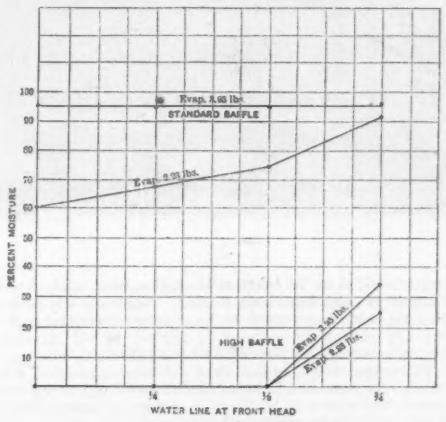
Fig. 3

The main steam header, 16in. diameter, is mounted on the boiler-room side of the wall separating the boiler and engine-room. Steam from the north row of boilers is carried across the room by elevated mains passing above the south row of boilers, from which steam is gathered by branch pipes leading into these mains. Engines A, B, C, D, E, K, and L take steam directly from the main header, by means of pipes which pass through the wall; the diameter of these steam connections are 8in. for the small engines, 9in. for the medium, 14in. for engine K, and 12in. for engine L. By means of five tie-over lines leading from the main header, extending down below the floor, and across to the other side, steam is conveyed to a header also below the floor, which serves engines F, G, H, I, and J. The steam system of that portion of the plant not shown is connected with the header which serves engines F to J.

The main header in the boiler-room is in the three portions, one division receiving the steam from boilers Nos. 1 to 8, another from Nos. 9 to 12, and the third from boilers Nos. 13 to 21. Thus there are three individual groups of boilers discharging their steam to individual headers, which are joined by a 9in. equalising pipe. These different boiler groups are shown by differently indicated steam drums. Thus the boilers may be designated as east, middle, and west groups.

MANIFESTATION OF TROUBLE.

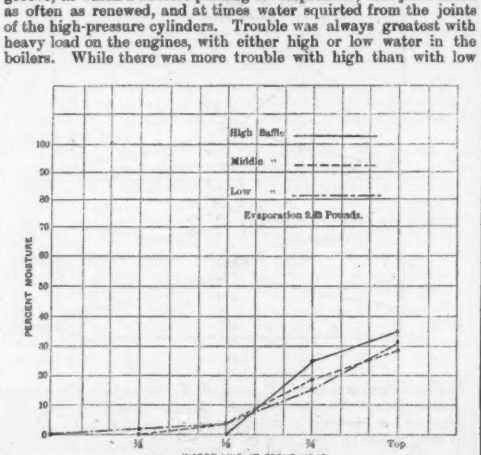
Previous to the occurrence of the troubles to be described, the plant contained engines A to J and boilers Nos. 1 to 14, and there had been no apparent indication of moisture in the steam being over 1·5 per cent. It was the practice just before the peak of the load to fill the boilers to a considerable height, for the purpose of realising the advantage of a stored water supply during the heavy load, and there was no trouble caused by this practice.



RESULTS OF TESTS OF BAFFLES.

Fig. 5

In the installation of the west group of units, boilers Nos. 13 and 14 were detached from the middle header, and included in the west group, comprising engines K and L, and boilers Nos. 13 to 24. When this new group was put in service, water was carried to these two engines, resulting in much trouble, failure to effect lubrication of valves, resulting in their not closing, and the breaking of valve arms. The joints between the cylinders is a tongue and groove, in which a flexible packing is compressed; this joint failed as often as renewed, and at times water squirted from the joints of the high-pressure cylinders. Trouble was always greatest with heavy load on the engines, with either high or low water in the boilers. While there was more trouble with high than with low water, these conditions had less effect than did the engine load. The amount of water passing the high-pressure cylinders was so great that the drains from the intermediate receiver were not sufficient to remove it; for this reason they were increased in area. These engines have a manhole through the top head of the low-pressure cylinder, closed by an inner and outer cover. Before the receiver drains were enlarged, the accumulation of water became so great on one occasion as to cause a sufficient quantity to enter the low-pressure cylinder to break the bolts holding the inner cover. Owing to the failure of the high-pressure steam valves to close, the receiver pressure would rise to at least 40 lb., at which point the relief valve was set; this extreme pressure under the low-pressure piston was sufficient not only to raise the shaft, fly-wheel, generator, &c., but on one occasion caused one of the 4in. bolts which holds down the cap of the main journal to be pulled up a sufficient amount to allow the revolving fields of the generator to strike. It goes without saying that the various troubles above outlined were of such occurrence as to require these two engines to be taken out of service quite often. There, however, were no such serious troubles as the breaking of cylinder.



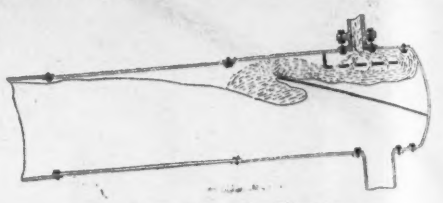
RESULTS OF TESTS OF BAFFLES.

Fig. 6

CAUSE OF TROUBLE.

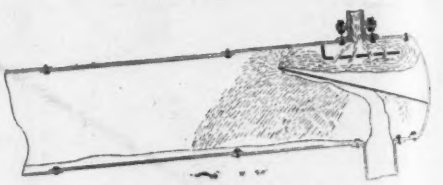
At the above stage of the case, the author examined the matter and attributed the cause of trouble to the water baffles in the drums of the boilers.

Fig. 2 illustrates the front end of the steam drums of a boiler. As will be observed, the baffle is set at an angle for the purpose of preventing the column of water from the front water leg, the water rising directly to the steam outlet. From the header the dotted arrow in Fig. 2 shows the supposed path of the rising water, and the full arrow the path the author considered a portion of the water would take. In other words, if the flow of steam was rapid enough it would cause some water to be projected to the end of the baffle, from which point it would be carried into the space above by the high velocity through the contracted passage above the top end of the baffle. As a remedy it was proposed to replace the baffles with that shown in Fig. 3, which is designated as the middle form. It will be observed that it is located at the centre of the drum, and affords equal volume of space above and below, and provides a large area or passage above, and ensures a lower velocity of escaping steam. Two other styles of baffles are shown in Fig. 3 which will be mentioned later; the three styles being presented in one figure for simplicity.



HEINE BAFFLE. HIGH WATER LINE.

Fig. 7

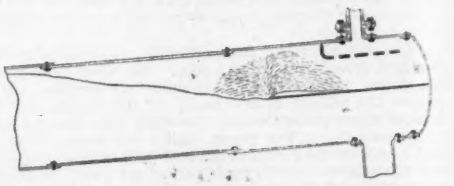


HEINE BAFFLE WITH LOW WATER LINE.

Fig. 8

FIRST ATTEMPTED REMEDY—SMALL SEPARATORS.

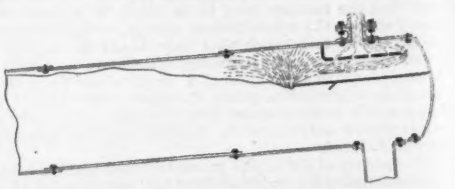
Instead of the proposed baffles being adopted, separators, shown by Fig. 4, were placed in the steam pipes to these two engines, that for engine L being 7·5ft. in length and 23in. inside measurement, with 12in. steam openings. The path of steam through these devices is shown by arrows, there being a perforated copper lining as shown. A perforated partition located above the bottom, also two gutters surrounding the central outgoing passage, provided for drainage by a down pipe as shown, the apparent idea of these separators being that the water would flow down the surfaces of the inlet portion of the device and be caught by the perforated lining and gutters, and reach the bottom chamber, from which it would be removed.



MIDDLE FORM OF BAFFLE.

Fig. 9

When these separators were first put in service, the force of the flowing steam and water tore out the copper linings, which were about 0·12in. thick, and they were carried through the high-pressure cylinder into the intermediate receiver, some portions passing through the tubes of the superheater and landing at the low-pressure end. One piece too large to get through became wedged under the throttle valve of one of the engines, and to stop it required that the steam be shut off in the boiler-room. Another piece got between the piston and cylinder wall, where it remained till worn away. Steel linings were then inserted, but there was no evidence that these separators removed any of the water which entered with the steam; their presence, however, added to the steam storage space, and for this reason reduced by a small amount the water leaving the boilers, for reasons that will be explained later. Each separator had a Bundy steam trap located in the basement below the engine-room, for the purpose of removing the water which it was expected would be collected, but it appeared that all the water discharged by these traps could be accounted for by condensation in the lower part of the separator, in the drain pipe and trap. Sometime before these devices were installed, the water line in the boilers was reduced to about 1in. in the bottom of the gauge glasses, at which point it was maintained. This, together with the increased volume of steam storage space, owing to the addition of the separators, resulted in the trouble from water in the engines being reduced by a noticeable amount, but enough to be of slight benefit only.



HIGH BAFFLE WITH HIGH WATER.

Fig. 10

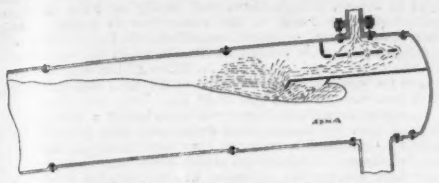
* American Society of Mechanical Engineers, New York meeting.

EXPERIMENTAL INVESTIGATIONS WITH SPECIAL BOILER.

While the problem was at this stage the author began a series of experiments, the results of which follow. During their progress, however, it was decided to equip these two engines with still larger separators, which has now been done.

That the action of different water baffles could be thoroughly studied, a small working model of the boilers was made, and fitted with a glass steam drum, so that the entire performance was visible. The heads of the drums were removable; to the front one different forms of baffles were attached for test.

The boiler was heated by one blast flame in the tests, which gave an evaporation at the rate of 2·23 lb. of water per square foot per hour, and by two blast flames in those with an evaporation at the rate of 3·95 lb. The air pressure for these flames was supplied by a fan direct connected to a small electric motor, which ran at uniform speed. The gas supply was constant for every experiment. Steam and water was discharged from the boiler by a pipe, which entered a glass bottle of about the same



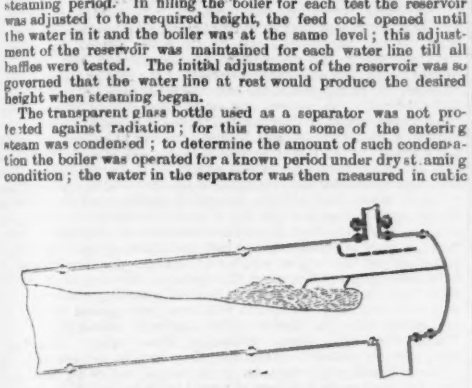
HIGH BAFFLE WITH MODERATELY HIGH WATER.

Fig. 11

cubic capacity as the boiler, passing through a rubber stopper, the steam escaping to the atmosphere by another pipe in the stopper, and the water remaining in the bottle which acted as a separator. The feeding arrangement consisted of an adjustable reservoir, provided with a wide overflow, into which warm water continually ran, the surplus escaping. This reservoir was connected with the front water leg of the boiler by a rubber tube attached to a pipe provided with a feed cock. A glass water gauge was provided at both front and rear of the boiler.

The experiments consisted in tests of different baffles, at two rates of evaporation. Also four different heights of water line, which were determined by the front gauge glass, according to certain heights on the front head of the steam drum. These water lines—shown in Figs. 5 and 6—were those at the beginning of the steaming period. In filling the boiler for each test the reservoir was adjusted to the required height, the feed cock opened until the water in it and the boiler was at the same level; this adjustment of the reservoir was maintained for each water line till all baffles were tested. The initial adjustment of the reservoir was so governed that the water line at rest would produce the desired height when steaming began.

The transparent glass bottle used as a separator was not protected against radiation; for this reason some of the entering steam was condensed; to determine the amount of such condensation the boiler was operated for a known period under dry steaming condition; the water in the separator was then measured in cubic



HIGH BAFFLE WITH NORMAL WATER LINE.

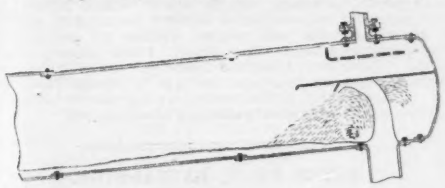
Fig. 12

centimetres, and divided by the number of minutes of the test. Thus a constant was established for all tests.

The performance consisted in the evaporation, or evaporation and discharge of a measured quantity of water, and were not continuous tests at constant water line of regular interval in duration. In each the process was continued till the water line fell to a point equal to two-fifths of the height of the front leg, measured from the bottom of the leg after the fire was shut off. Thus, during steaming at the end of the tests the water line was below the upper tubes at the front, but above them in the rear. Measurements of the various quantities above this final water line for the various initial water lines having previously been made, the different quantities for each test was known.

In making the test the initial water line was secured, the feed cock closed, and fire applied. At the moment steaming began time was taken; when the end of the experiment was shown by the height of the water in the front gauge time was taken and fire shut off. The radiation constant multiplied by the duration of the tests in minutes gave the total condensation which, subtracted from the water in the separator, gave the total water carried out with the steam; this, referred to the original quantity, gave the percentage of moisture in the steam made. The average duration of a test was from 30 seconds to 10 minutes, depending on the baffle and height of initial water line. Altogether 167 regular and a large number of preliminary tests of similar character were made; the results given are based on 93 experiments.

The steam pressure with the tests at low rate of evaporation was



HIGH BAFFLE WITH LOW WATER.

Fig. 13

equal to a water column 6in. high, those at higher capacity gave a pressure equal to 10in. of water. These pressures were due to the resistance of the steam passages which terminated to the atmosphere. The tests were, therefore, made at practically atmospheric pressure. For this reason the size of the steam bubbles were very large, which caused violent ebullition, much more than would be the case with higher pressure. This condition served to develop the relative values of the devices over a very large range, as the ejection of water with the standard form, at the high rate of evaporation was carried very nearly to the maximum.

RESULTS WITH EXPERIMENTAL BOILER.

Fig. 5 is a diagram of results of performance of the standard baffle which is illustrated in Fig. 2, and of the high form provided with deflectors shown in connection with others in Fig. 3. It will be observed that with the high baffle moisture is not carried out till the water line is above the middle of the front head; above this point it increases rapidly. At low rate of evaporation moisture increases with the standard baffle with increased height of water line, but at high rate of evaporation it remains practically constant, showing that if conditions are severe enough nearly all of the water will be ejected regardless of the height of water line. It is, of course, not to be inferred because the standard baffle allowed the escape of 95 per cent. of the water with the model that the large boilers do so. It means, however, under conditions that this device would produce 95 per cent. moisture, the high form of baffle with deflectors would make dry steam, and that this improvement in service would possess enormous margin over any dry steaming requirements.

Diagram Fig. 6 gives comparative performance of the three styles of baffles illustrated in Fig. 3. It will be observed that when the water line was below them, that dry steam was produced; but when it was above each allowed of the escape of water, and that this amount was largest with those having the smallest space above owing to the consequent higher velocity of escaping steam.

The actual performance of the principal baffles, as viewed through the glass walls of the steam drum of the model boiler, is shown in Figs. 7 to 14, which are vertical half-sections of the drums of the large boilers, with different baffles shown therein.

Fig. 7 is the performance of the standard baffle with high water line, and Fig. 8 with low water. The first thing to occur when formation of steam began was the projection of a quantity of water up the under surface of the baffle to its end. From this point a portion fell back into the drum; the remainder was carried over the baffle and filled the space above. When this space had become

HIGH BAFFLE WITHOUT DEFLECTORS.

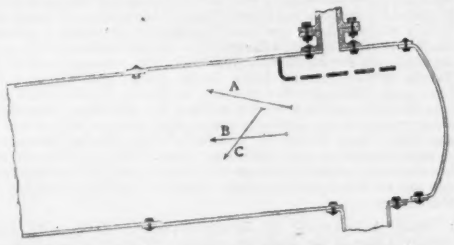
Fig. 14

filled, water began to leave with the steam, continuing to do so, as shown by Fig. 8, as long as the heat was supplied. The front gauge glass with such condition would indicate a water level lower than the bottom of the drum, yet the circulation would rise as shown. The water would pile up in the back of the drum when there was a large quantity in the boiler, but when reduced to a small amount would flow in a thin stream along the bottom.

Fig. 9 serves to show the tendency of the action of the middle form of baffle with the surface of the water at the level of its end, about one-half of the spray would be carried on to it, but owing to the low velocity of the outgoing steam above, would flow back instead of being carried out.

Figs. 10 to 13 show the performance of the high baffle provided with two deflectors. This excellent device was the outcome of experiments with the middle form. Without the deflectors, as shown in Fig. 14, it was more efficient than the middle form, but like it, the flowing water passed the end, where it rose in a spray. For this reason the author added the deflectors, for which there was ample room on account of its height, with the result that the water was projected downward.

Fig. 15 illustrates the angles of deflection of the different baffles A represents that of the standard, B the middle, and C the angle of the deflectors of the high baffle. It will be observed that the difference in angle between B, a very efficient device, and A, an extremely inefficient one, is slight, but that the area above their



ANGLE OF DEFLECTION, DIFFERENT WATER BAFFLES.

Fig. 15

ends is very different. Also that the effect of the deflectors is to project the water in a direction away from the steam outlet.

It was shown in the experiments with the model boiler that the water rose from the front leg with sufficient force to project it to the top of the standard baffle, and it was desirable to ascertain to what height it would rise if no obstacle intervened. Steam was removed by a pipe extending back in the drum about one-third of the distance from the front end; a glass stand-pipe was mounted above the regular steam outlet, its upper end being in communication with the steam space in the boiler, so that pressure would equalise above the column of water therein. The baffles were removed so that the rising water from the leg could reach the opening to the standpipe. Fire was applied, and at the moderate rate of evaporation water rose in a solid column in the standpipe to a height equal to that of the water leg, and at high rate of evaporation to a height nearly twice as great.

(To be continued.)

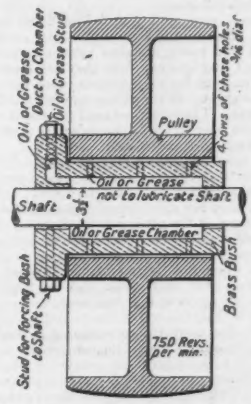
MANCHESTER ASSOCIATION OF ENGINEERS.—The annual meeting of the Association was held on Saturday evening, Mr. Alfred Saxon, president, in the chair. Various alterations were made in the rules whereby the present president and other officers remain in office until March, and it was also resolved to apply for membership of the Manchester Chamber of Commerce, the president remarking that it might be of interest in furthering engineering progress in the district. A paper on "The Economic Value of Cast Iron" was read by Mr. W. H. Pretty, A.M.I.C.E., of Bedford. He said cast iron in various forms and qualities was a commodity so readily obtained in this country at the present time that they were apt to forget its true economic value in the arts and industries in which it plays a part. This in its turn led to an almost inexcusable neglect on the part of engineers and others of what was one of the most fascinating, valuable and educational industries we possessed. At the same time, it was an aid in engineering work which could not be despised. There were, however, many factors involved in the maintenance of standard qualities, rendered more complex by the great range in quality and price of pig iron, &c., each of value for particular purposes, at the founder's disposal. Additional factors had been introduced by the demand for high-cutting speeds in modern machine tools, and by specifications for strength and casting conditions from various quarters, too often indicative of the gulf separating the iron foundry from the remainder of the engineering world. The paper was illustrated by photographs of tools with fixed cutting angles taken while actually at work upon cast iron by means of microscope and camera. Foundry traverse testing machines by Bailey, S. Denison and Sons, and Avery were on exhibition, as also specimens of cast iron bearing upon the necessity of combined chemical and physical tests, chills and their uses, the occlusion of gases, &c.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

HOT BRASSES.

SIR,—In reply to "Hot Brasses" in your issue of the 9th inst., I enclose you a rough sketch of a bush we are using for a pulley 12in. wide by 16in. diameter, and running at 750 revolutions per minute, driven by a belt 11in. wide, about 20ft. centres. You will notice that the bush is recessed about ¼in. deep almost the full length of the boss, and is fixed to the shaft by a stud, so that if the bearing be neglected the bush wears and not the shaft. The bush is also provided with a stud through whose holes the lubricant is fed, and finds its way into the recess in the bush through a duct cut from the bottom of the stud holes. In this particular case we have found oil not satisfactory, as it gets away too quickly; we therefore got a garden squirt about 20in. long by 1½in. bore, fitted with a screwed nozzle to fit the stud holes, and we put a quantity of Asbestoline into this squirt and warm it to make it more fluid. The lubricant is then forced into the bush by the squirt. I may say that to convey the lubricant from the recess in the bush to the bore of the pulley we have four holes ⅛in. diameter drilled in lines and at four points round the bush, so


Oil or Grease Duct to Chamber
Oil or Grease Stud
4 rows of these holes ⅛ dia.
Pulley
Oil or Grease not to lubricate Shaft
Shaft
Oil or Grease Chamber
Stud for forcing Bush to Shaft
Brass Bush
750 Revs. per min.

BUSH FOR HIGH SPEED PULLEYS

that at whatever point the pulley may stop one or other of the holes will be near enough to the bottom to allow the lubricant to run into the boss of the pulley. We have now run this pulley for six months, and it has given no trouble. With lighter drives oil does very well. We have a great number of them running, and have had for years. One great advantage is that no wear takes place on the shaft, and the bushes are not costly and are easily replaced. In the particular case I have mentioned one of the bushes, which got worn when we used oil, I have had skimmed down and coated with white metal, and keep it ready in the event of the one in use wanting to be replaced. When oil is used it is put into the hole of the oil stud with an ordinary oil feeder, no pump being necessary as in the case of this semi-solid lubricant.

December 10th. W. RIDER.

SIR,—In reply to your correspondent, "Hot Brasses," if, instead of brass bushing his loose pulley, he will pin the brass on the shaft, and allow the pulley to run thereon, his trouble will be at an end. At least, that was my experience in a very similar case.

ROBERT SPROULE.

205, Uxbridge-road, London, W.,
December 10th.

H.M.S. TERRIBLE.

SIR,—I do not know that I can add much to what I have already written, but I can inform "Perplexed" that the Terrible had some 200 extra men on board during her last trip. She never, however, carried so few as 700. So his figures require re-editing under the culinary item.

I hardly think he is quite correct about the Speedy. I do not fancy that she has steamed to any abnormal extent. She was the solitary ship in all her class that steamed up to expectations with the originally-fitted boilers—Thornycroft in the Speedy, cylindrical in the others—and so gained herself a good name. I doubt whether she has done more steaming than either the Powerful or the Terrible.

As regards the leaky steam pipes, to which both "Perplexed" and "Superintendent Engineer" allude, they had nothing to do with Thomson's yard so far as I know, but were a matter of Admiralty design. The standard steam pipes sanctioned by custom were employed in these as in other early Belleville ships. Except for economisers, the Bellevilles of the London and Drake classes are substantially identical with those of the Terrible and other ships of her era. The Bellevilles of these later ships give no trouble; in the Terrible, &c., they did. The newer ships have steam pipes designed to carry 300 lb. or so, those of the Terrible, &c., were for about 150 lb. Now these ships have the new regulation installation, and trouble with them has ceased. This is a Q.E.D., if your correspondents prefer it, to what any engineers who have served in the Powerfuls and Diadems could tell him.

I am quite aware that in the Terrible a weldless tube once burst with fatal results, but, as this was one of several experimentally fitted along with the other type of tube, it is beside the point. The fact remains that the steam pipes, as originally fitted, were the cause of the Terrible's early troubles.

The Terrible has no special anti-fouling composition on her bottom, as "Perplexed" hazards.

I have a suspicion that were a careful investigation made it would be discovered that in the 1902 return optimistic ideas of horse-power bore some part. Anyway, that is one surmise which will account for much. Of course, it makes the 1902 consumption still worse, but I fancy that there was a record state of dirtiness to help to account for it. Dirty boiler casings are not uncommon in the Navy now and again, as the variations in upkeep cost under this head indicate.

December 15th. NAVALIS.

RAILWAY ACCIDENTS.

SIR,—The article which appears last week, page 573, shows that by the introduction of the block system, continuous brakes, and also the excellent state of the permanent way, accidents in this country have been greatly reduced. On the other hand, we in England suffer from a class of accident unknown in America, namely, tank engines running off the line, and it is this particular class of accident which causes so much loss of life and injury in Great Britain.

Having examined all the important railway wrecks in this country during the past thirty years, I am able to turn to note-books with the details written on the spot. During the past twenty-two years these notes show that I have examined twelve cases, all of which are due to one and the same cause. The particulars of the examinations show:—(1) The permanent way

in good order; (2) the engine and train in good order; (3) the engine which left the line is a tank engine, and the accident is due to the oscillation of the engine. In some cases the permanent way has been burst, and in others the wheels of the tank engine have mounted the rail, crossed over the top, and fallen on the other side.

In all these twelve cases the oscillation was caused by the speed of the train being too high for the tank engine to run steadily. Of course, I only refer to the twelve instances which I have examined, but there are several others recorded in the Board of Trade returns.

This, it will be seen, is a class of accident in which the men and the permanent way department are not to blame, and there is no mechanical failure of the engines; the sole fault is that the tank engines are not fit for fast running, and this fact has been pointed out for many years by the Board of Trade inspectors.

Leicester, December 10th. CLEMENT E. STRETTON.

ROARING RAILS.

SIR,—I have been much interested in the article appearing in your periodical by Mr. H. L. Wilkinson under the above heading. I must say that I have never heard the term before, but I have for a long time had rails which have emitted the peculiar sounds referred to. My investigations, however, have led me to attribute the cause somewhat differently.

The rails in question were, I found, laid down some eleven or twelve years ago, after having been in stock for some considerable time. They had got rusty, and the table of the rails had got pitted. I have not any analysis, but they are evidently hard, as, although they have worn for some twelve years, the pitting has not worn out, and the surface of the rail is very similar to the diagram shown in your issue. These rails extend for about a quarter of a mile, and it is quite easy to tell with one's eyes shut where you are the moment the train gets on to them.

As is stated, I have never heard of iron rails behaving in the same manner; but this brings us to the vexed question of steel, which is so liable to pitting both in bridgework, boiler plate, and also in rails when they are not properly stacked and cared for.

I believe the reason of the pitting to be the want of homogeneity in the steel, as why should a boiler plate or bridge member be pitted in one place and perfectly free from rust or pitting in other places? and even when the pitting has been cleaned with a wire brush and painted over with good red lead paint, it almost invariably breaks out again in the same spot.

My experience is that the worse the steel the lower the carbon, or, in other words, the more it approximates to wrought iron, the better it seems to stand against pitting and rust.

For cheapness of maintenance and durability where atmospheric conditions are adverse give me good wrought iron made fifteen to twenty years ago, which it seems impossible to get now.

WILLIAM MARRIOTT.

Melton Constable, Norfolk, December 7th.

PUMPING MACHINERY, CARDIFF DOCKS.

SIR,—In your issue of the 10th inst., describing some centrifugal pumping machinery for the docks at Cardiff, we notice one or two erroneous statements.

(1) You say that the centrifugal pumps are claimed to be the largest that have been manufactured.

We beg to inform you that we supplied some years ago two larger, viz., 60in. pumps with 8ft. discs for No 3 Graving Dock of the Clyde Trustees, which were fully illustrated in your paper, and from an inspection of the drawings you will see that the pumps you now describe show a strong family likeness. Please refer to your paper of the 15th of July, 1898.

(2) With regard to the pumps being set in a novel way in the engine-house, *i.e.*, in echelon fashion, we would refer you to the large installations supplied by us to the Mersey Dock and Harbour Board in 1887, from which it will be seen that the three sets you now describe are arranged in an exactly similar manner to these.

GWYNNES, Limited,
JOHN GWYNNE, Managing Director.

81, Cannon-street, London, E.C., December 14th.

LENGTH OF MOTOR CARS.

SIR,—In a recent lecture at this Institution the Hon. C. S. Rolls drew attention to the steadily increasing length of motor vehicles, and the consequent difficulty of turning in a road of ordinary dimensions. Many years ago I suggested the use of six wheels as a remedy to this, and I see no reason at the present time to modify the idea then put forward. The tendency now is to use wheels of absurdly small diameter, considering the weight that they carry, and, in the case of pleasure vehicles, to remedy this cardinal defect by the employment of costly pneumatic tires. Centrally-placed driving wheels of, say, 5ft. diameter ought to obtain a good grip of the ground without unduly sinking into it, and though the steering wheels, at either end, need not be made as large as this, a generous increase of diameter would be desirable. Ample length in a motor car is, without question, the proper thing, but there is really no reason why it should involve unhandiness in turning.

London Institution, December 10th. A.

REACTION IN A DIVERGING NOZZLE.

SIR,—If Mr. Nielsen will think the matter out, he will see that the recoil conditions are precisely those obtaining in a Barker's mill or the bucket of a De Laval turbine. If the nozzle moves away from the jet as fast as the steam issues, it is clear that there can be no recoil thrust, unless indeed the conservation of energy is not true.

If Mr. Nielsen is right, then we might construct a water turbine, for example, in which the guide blade wheel would revolve in one direction, giving out 80 per cent. by recoil, and the blade wheel in the opposite direction, also giving out 80 per cent. by direct or impact action. We should thus get 160 per cent. out of a given water delivery. I have not claimed more for either wheel than has actually been obtained in practice. I fancy that Mr. Nielsen has overlooked this line of argument.

The case of a gun does not apply, because the shot is already moving with the gun and the earth when the charge is fired, and possesses, as far as space is concerned, the momentum proper to its velocity.

My reason for asking about the place of effort in a diverging nozzle is to calculate the area on which that thrust is exerted. It seems to be obviously greater than 1in.

December 14th. TESTOR.

AUSTRALIAN NOTES.

(From our own Correspondent.)

A FALLING-OFF in coal shipments is shown by the Sub-collector of Customs at Newcastle, N.S.W. For the nine months ending 30th September a decrease of 407,301 tons is shown, as compared with the corresponding period in 1903. The principal places of export are as under:—Victoria, 612,841 tons; Chili, 340,276 tons; South Australia, 293,535 tons; Philippine Islands, 163,693 tons; New Zealand, 178,641 tons; United States, 139,004 tons; total exported, 2,226,370 tons. It was announced by the Newcastle colliery proprietors, a short time ago, that they intended to reduce the selling price of coal as from 1st January next, and in conformity with the agreement with the employés the hewing rate was to be reduced according to the sliding scale in operation. This was objected to by the men, who brought the case before the Arbitration Court. The Court has now ruled that the signatories to the agreement of 1893, or their substitutes, can declare the price, but that they must do so in September of each year for the twelve months commencing with the ensuing 1st of January.

In connection with the new central railway station, Sydney, now in course of erection, a further estimate of the cost has been prepared by the Under-Secretary for Works, which has been given as under:—

	£
Removal of bodies from cemetery site	49,431
Demolition of buildings	3,387
Land for station and approaches	337,248
Station works and buildings	504,702
Cost of completing buildings	165,000
	£1,059,768
Less estimated amount to be realised by sale of surplus land	165,000
	£894,768

South Australian railways have been following out the principles of the other State railways in having the trucks loaded to their full capacity, and saving of train miles. For the year ended 30th of June last a decrease of 31,263 train miles was effected, although £84,000 more was earned. The results of the working for the year show a return of 3·59 per cent. on the capital invested, which indicates a return to more prosperous times.

Consideration is being given to the question of electrifying some of the suburban lines, and the Commissioner urges that no time should be lost in deciding the matter, as the present uncertainty as to alterations in the tracks have necessarily occasioned delay in bringing up to standard condition the way and works of some portion of the line. For the purpose of effecting further economies steps have been taken for the gradual introduction of motor inspection cars and tricycles, by which means the transportation of men and materials can be improved.

Expenditure has been increased by £50,884 in (*a*) repairing damage done by floods in the North; (*b*) the necessary re-laying of parts of the permanent way, and the securing of second-hand rails for the Glencoe line; (*c*) an exceptional outlay in improving the condition of engines; and (*d*) the purchase of thirteen locomotive boilers. An increase of 40,620 tons in mineral traffic has been carried from the Barrier fields, and it is expected that an increase of this traffic will be maintained for some time to come. The following summary shows the working of the traffic for the year compared with the previous year:—

	1904.	1903
Miles open	1,786½	1,736½
Average miles open for the year	1,736½	1,736½
Capital cost on lines open	£13,517.7 7	£13,400,796
Capital cost per mile open	£7,785	£7,718
Gross revenue	£1,160,639	£1,076 612
Working expenses	£675,395	£624,511
Net earnings	£485,244	£452,101
Working expenses to earnings p c.	58·19	58·01
Net revenue to capital cost, p c.	3·59	3·37
Train miles	3,739,088	3,770,351
Passenger journeys number	9 747,412	9,061,488
Goods and live-stock, tons	1,515,611	1,349,617

BRADFORD ENGINEERING SOCIETY.—The fifth lecture of the session was given on Wednesday evening, the 30th ult., at the City of Bradford Technical College, by Mr. G. H. Bowden, on the "Advantages of Electric Driving in Works and Factories." The lecturer dealt in a general way with the substitution of electric motors for long lines of shafting, awkward gearing, or small wasteful steam engines, giving numerous instances from his own experience where a saving in the cost of working had resulted. He dealt more particularly with the advantages of the application of electric driving in steel works and rolling mills, and noted the facility with which the machinery for dipping plates into "pickling tanks" could be operated electrically. A long discussion followed, in which the President, Prof. Charnock, who occupied the chair, Messrs. Jones, Duncan, Hiles, Croft, Noble, and Wigglesworth took part. Through the kindness of Messrs. Walter Scott and Co., Limited, and their works manager, Mr. Richards, some sixty-six members of the Bradford Engineering Society paid a visit to the Leeds Steel Works on Tuesday evening, the 6th December. A most interesting two hours were spent with Mr. Richards and his assistants, whose courteous explanations and able piloting from one part of the works to another were thoroughly appreciated by the visitors.

LEEDS ASSOCIATION OF ENGINEERS.—The thirty-ninth anniversary dinner of the Leeds Association of Engineers was held on Saturday, 3rd inst., at the Queen's Hotel, Leeds, when 210 members and guests were present. The chair was occupied by Sir James Kitson, who, in proposing the toast of the evening—"Prosperity to the Association"—alluded to his recent visit to America with the Iron and Steel Institute. What struck him most was the American engineer's talent for developing old ideas. He thought he was right in saying that, with one exception, all original ideas had come from the Old World, and had been developed in the New. Speaking of the manufacture of iron and steel in America, he said:—"We here in this country work under entirely different conditions, and I think there is no reason to say the Americans are doing so very much better than us because they are supplying their great market with masses of material, or that we are doing so much worse, because all our conditions are different. Our products are different, and in the main I unhesitatingly say our products are vastly superior to those which are considered sufficient for the requirements of the American continent. Therefore, I say, we need not depreciate ourselves by elevating too much the Americans, but we may elevate ourselves by endeavouring to imitate those things which facilitate so much their own manufactures and their own productions."

ELECTRIC EXHIBITS AT ST. LOUIS EXHIBITION.—Mr. S. E. Tedden, manager of the Sheffield Corporation electric supply department, has presented to the City Council a report on his recent visit to the United States and Canada. Mr. Tedden, whose report is a volume of 68 pages, visited New York, Chicago, St. Louis, Schenectady, Pittsburgh, Boston, Montreal, Quebec, Ottawa, Toronto, and Niagara. Dealing with the St. Louis Exhibition, Mr. Tedden says that his first impression, especially of the electricity section, was one of disappointment. European exhibits of large machinery were conspicuous by their absence, England, France, Germany, and Italy being represented in the electrical department mostly by small instruments, for which gold medals have been awarded to more than one English exhibitor. The Exhibition, he thinks, has followed too closely on the Paris display of 1901 to expect many novelties, and electrical machinery has now reached great efficiency and perfection, and become to a large extent standardised. Mr. Tedden, concluding with some general impressions of the Exhibition, specially notes the immensity of the scale of the electric lighting effects, the undoubted advance in the construction of steam turbines, the great increase in size of the modern generators and engines, as well as the extended employment of electric motors for the driving of all kinds of machinery, and the very large number of engineers engaged in experimenting with new firms of lamps for use on electricity circuits, all tending to decrease the cost of consumption. "Our own work," added Mr. Tedden, "has made such strides in the last few years that to-day we need fear no comparison with American methods in point of scientific development, and although, in the nature of things, most of our undertakings are on a smaller scale, there is undoubtedly a high average of excellence to be found in English practice, and greater consideration for the comfort and safety of the general public. Much of the work to be seen in the States is obviously designed to meet, as cheaply as possible, the demands of the moment. It seems to be generally considered improbable that any more very large general Exhibitions will be held, their object being much better obtained by smaller special displays."

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE engineering trades are well engaged upon finishing contracts which have to be completed before the Christmas holidays. The electrical and hydraulic engineering industries are the busiest, though a good deal of work is still under execution in connection with railway and tramway rolling stock construction, both bodies and underframes. The demand for machine tools, including lathes, has gone rather quiet again. Gasholder makers are fairly well engaged, and so are the bridge and roofing makers. Some of the wrought iron tube firms have good contracts in hand, whilst others are only quiet, employment in this branch being irregular.

There was again a good market on 'Change in Birmingham on Thursday, and prices were sustained at a fairly remunerative level to sellers, though there was hardly as much firmness in galvanised sheets owing to the easier tone of spelter. Marked bars were £8, and common unmarked, £5 15s. to £6; whilst sheets, singles, were quoted £6 12s. 6d. to £6 17s. 6d.; doubles, £6 15s. to £7; and trebles, £7 7s. 6d. to £7 12s. 6d. Hoop iron was in fair demand at £6 12s. 6d. to £6 15s.; and nail rod and rivet iron was quoted £6 10s. to £6 15s.

In regard to pig iron there was experienced a tolerably good demand both for foundry and forge sorts, with prices well maintained. Considerable amounts have been arranged for for next year's delivery. Staffordshire cinder forge was quoted 42s., and part-mine, 44s. to 46s. All-mine was in tolerably good request, and the recent level of prices was maintained at—ordinary, 55s. to 60s.; and best, 75s. to 80s. Cold blast was in limited output for special purposes at 95s. to 100s.

Steel makers have been doing considerably better of late than for a long while past, and have been freed from foreign competition recently in a gratifying manner; but how long they will continue to enjoy this immunity is problematical. Meanwhile, Bessemer billets are quoted £4 5s. to £4 7s. 6d.; and Siemens, £4 12s. 6d. to £4 15s.; whilst mild steel bars have been this week in fairly good demand for engineering purposes at £6 to £6 5s.; and girder plates have recently been put up half-a-crown, and were quoted on Thursday £6 to £6 12s. 6d.

Much satisfaction is expressed throughout the iron and steel trades in this district at the circumstance that the Midland Iron and Steel Wages Board is to be continued. The new sliding scale, which is to be arranged by the Standing Joint Committee, will doubtless be satisfactorily constituted. At a general meeting of the whole Board on the 12th inst., Sir Benjamin Hingley presiding, the following resolution was passed:—"That having had the results of the recent canvass of employers and operatives in South Staffordshire, Shropshire, and South Wales placed before us and recognising the desirability of maintaining the Midland Wages Board, not only in the interests of the iron and steel trades affected, but in support of the reasonable principles of conciliation and arbitration, we confirm and ratify the resolutions passed by the Sub-committee on November 17th, and by the Standing Committee on December 1st, and pledge ourselves to become subscribing members of the Board, and conform to and observe the rules and decisions thereof." In the course of the proceedings, the chairman stated that the employers had ascertained that thirty-four works in South Staffordshire, three in Shropshire, and six in South Wales were willing that the Board should continue in existence, and he explained that those firms represented the bulk of the trade, as they produced the largest quantities of iron and steel, and employed the largest number of workpeople. On the other hand, twenty-seven firms took the opposite view, but their works were very small—some of them had no puddling furnaces, and only made bar steel—compared with those who wished to remain connected with the Board. The chairman added that South Wales was with them, although there they maintained their own organisation. They were, however, in alliance with the Midland Board, and every change in wages and every alteration that had been made had been observed by them loyally and truly, as though they were part of the Board. He further added that North Staffordshire, Lancashire, South Yorkshire, and Derbyshire were also in friendly alliance with the Midland Board, and were desirous that its existence should be maintained. Both employers and men in the Midlands should, he urged, always have regard to the state of trade, not only in their own district, but also in the North of England, Lancashire, North Staffordshire, Scotland, and elsewhere. The proceedings throughout were mutually conciliatory as between the employers and men. The first meeting of the Standing Joint Committee to consider the basis for a new sliding scale has been fixed for the 9th of January.

Messrs. Cochrane and Co., of the Woodside Ironworks, Dudley, have received an order from the South Staffordshire Waterworks Company for cast iron pipes to the value of between £7000 and £8000, and have re-lighted a blast furnace to make the necessary pig iron. Messrs. Joseph Sankey and Sons, of Bilston, are understood to be completing arrangements for the purchase of the Manor Sheet Ironworks, from Messrs. Stephen Thompson and Co., of Spring Vale, Bilston.

A new type of motor van of 24 horse-power, for the conveyance of passengers and mails over long distances in Cape Colony, is being constructed by the Wolseley Tool and Motor Car Company. The new vehicle is designed to carry six passengers, a driver, a conductor, and about 10 cwt. of mails and luggage. The weight of the van empty, but fully equipped, is about 1½ tons. The frame is of steel, and the tires are 3in. solid rubber. The motor has four cylinders. The gearing provides four speeds forward—7, 12, 20, and 26 miles an hour—and one reverse. Under average conditions the van will be equal to a 70 miles journey on one load of petrol, the tank carrying 10 gallons. Accommodation is provided for small guns. A company, with the title of "Climax Motors," has been registered with a capital of £5000 to manufacture and deal in motors, carriages, and vehicles, whether for propulsion by steam, electricity, oil, or other power. A new company, known as the "Mechanical Advertiser Company," with £2000 capital, has been registered to acquire the right of Thomas Turner and Co., Wolverhampton, to the manufacture and sale of a mechanical contrivance for automatically changing advertisements.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—The attendance on 'Change on Friday was exceedingly good. The decline in Middlesbrough warrants did not affect the market here, and pig iron makers did not show any disposition to offer forward in consequence. Indeed, there was little or no excitement observable, notwithstanding reports of excited markets in the States, and, generally, it is regarded that the decline was of a temporary nature. Meantime, warrants have shown a decidedly better tendency, and holders do not manifest any disposition to part with their holdings. This is certainly the feeling in this centre. As was the case last year, the recovery in trade has not been confined to pig iron. American iron is off the market, and stocks are comparatively small. On the other side, quotations are going higher, so that there is apparently little chance here, notwithstanding "bear" operations, of prices going lower.

Finished iron is exceedingly steady, and inquiries are more numerous. The steel trade is also fairly satisfactory, and good orders have been placed for constructional steel. The boiler making industry continues very slack, but machine tool makers are fairly employed, and there is a continuance of the better feeling in the textile machinery branch. Orders for locomotives come in in small quantities, but bar makers are busy. The electrical engineering department is also well employed.

In pig iron stocks in public stores continue to increase, though

not to any notable extent. There is about 50,000 tons more as compared with last year, but this, in face of fair demand, should be soon cleared. Quotations delivered Manchester are:—Lancashire No. 3 foundry, 52s. to 52s. 6d.; Lincolnshire ditto, 51s. to 52s.; Derbyshire ditto, 52s. to 53s.; Staffordshire, ditto, 52s.; Middlesbrough open brands, 55s. 10d. to 56s. 10d.; Scotch, Gartsherrie, 56s. 9d. to 57s. 6d.; Glengarnock, 55s. 6d. to 55s. 9d.; Eglinton, 54s. 3d. to 54s. 6d; and for prompt delivery Heysham, Gartsherrie 54s. 3d. to 54s. 9d., Glengarnock 53s. 3d. to 53s. 9d., Eglinton 52s. to 52s. 6d. East Coast hematite, 53s. 6d. to 54s. 6d. f.o.t., and West Coast ditto 56s. f.o.t. Barrow. Forge iron remains dull; Lancashire quoted 50s., Derbyshire 47s. to 48s., and Lincolnshire 49s. 2d. to 49s. 8d., delivered Manchester.

Staffordshire bars are quoted £6 5s. to £6 7s. 6d., Lancashire and Yorkshire £6 2s. 6d. to £6 5s., delivered stations; boiler plates, £6 17s. 6d.; hoops, £6 17s. 6d. to £7 2s 6d.; sheets ordinary, £7 5s.; ditto, C.R. and C.A., £7 15s. to £8, delivered Manchester. Steel bars, £6 to £6 2s. 6d; English billets, £4 10s. to £4 12s. 6d.; German, £4 2s. 6d. to £4 5s.; hoops, £7 5s. There is a quiet trade in manufactured copper. Prices are unchanged at £80 to £82 per ton for sheets. Seamless copper tubes are quoted 10d. per pound; ditto brass, 8d.; rolled brass, 7½d.; copper wire, 9d.; brass wire, 7½d.

The coal trade remains in a quiescent condition. The demand for best engine slack is exceedingly quiet. Forge and manufacturing coal is also dull. There is a falling off in the demand for shipment on the canal. Ordinary quotations are:—Best coal for domestic purposes, 13s. to 14s.; seconds, 12s to 13s.; common, 9s. to 10s.; steam and forge coal, best, 8s. 3d. to 8s. 9d.; best engine slack, 7s. 6d. to 8s.; medium, 6s. to 6s. 9d.; common, 4s. 3d. to 5s. at the pit Screened coal, ex Manchester Ship Canal, 9s. 3d. to 9s. 9d.; unscreened ditto, 8s. 9d. to 9s. 2d.

Barrow.—There is a fair business doing in hematite pig iron, but the market has not improved as much as was expected. There was a report that three additional furnaces were about to be put in blast, but this forecast was evidently premature. At several of the works no furnaces are ready to be put in blast, while at Barrow, Millom and Askam several furnaces could be lighted at once if there was trade to justify that course being taken. There are 24 furnaces in blast, and these are producing a considerable weight of iron. The four furnaces in blast at Barrow are making about 1000 tons of iron per week each. The makers are fairly well sold forward, and have cleared away much of the iron which had accumulated in their yards. They are confining their output to Bessemer sorts, which are in demand on the part of steel makers. The commoner classes of iron are not marketable. Prices are steady at 56s. 6d. for makers' iron net f.o.b., and 56s. 3d. for warrant iron net cash sellers, buyers 6d. less. The demand for charcoal iron is steady, and makers are likely to have a good run of orders for this specially valuable class of iron.

The iron ore trade is quiet, and the mines in the district are being indifferently worked. Prices are steady at 8s. 6d. to 10s. per ton net at mines for ordinary and best sorts.

The steel trade is fully employed so far as heavy rails are concerned, but there is only half employment for the plate and merchant mills. A good few orders are in the market for heavy rails, but there is a quiet demand for light sections and tram rails. Prices are steady for heavy sections at 85s. per ton. Ship plates are at £5 10s., and are in small demand.

No new orders are noted in the shipbuilding and marine engineering trades, but it is known that prospects are better, and that in all probability there will be secured before long some good orders for foreign Admiralty work.

Some large orders have been booked for shrapnel shells and for gun mountings, and these two local departments will be busy for some time to come.

The Dufferin, a troopship built by Vickers, Sons and Maxim for the Indian Government, left Barrow this week on her trial trip.

Shipping is busier. The returns for last week show exports from West Coast ports at 7265 tons of iron and 21,002 of steel; total, 28,267 tons; corresponding week last year, 21,492 tons; increase, 6775 tons. Aggregate for the year 704,628 tons; corresponding period of last year, 835,454 tons; decrease, 130,826 tons. Freights are low. Coal and coke firmer, and slightly higher in value.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE coal trade in the South Yorkshire district keeps in fairly satisfactory condition in nearly all classes of fuel. The very best quality of house coal and nuts are least in demand. For ordinary house coal there has been a somewhat animated request, owing to the weather, and sales for London are quite up to the average. In best Silkstones the price at the pit mouth is 13s. 6d. per ton, but there is not much call for this quality. Barnsley house, in which the largest business is done, fetches from 10s. 6d. to 11s. 6d. per ton in the best sorts; secondary grades from 9s. per ton.

In anticipation of the holidays, the steam coal pits are being pressed for deliveries, and rather more is, therefore, being sent to Hull. Contracts for locomotive fuel for next year are now engaging the attention of coalowners and railway managers. The contracts do not all expire at one time, but the tenders made for next year, whether for six or twelve months, are at 8s. 6d. per ton. It is expected that something will be definitely settled in the way of these contracts this week. In slack the improvement already noted is fully maintained; the Yorkshire and Lancashire textile trades being very busy, and heavy supplies are consequently being forwarded. Gas coal is being steadily delivered under contract, and, generally, the coal trade leaves small ground for complaint.

The Yorkshire coal trade with Hull for November amounted to 305,384 tons, as compared with 272,673 tons for November of last year. For the eleven completed months the weight was 3,271,648 tons, against 3,166,384 tons for the corresponding period of 1903. The increase on the month is just over 10 per cent. and on the eleven months a little over 3 per cent. Compared with October the business done shows a falling off of 49,856 tons, which is no more than normal at this season of the year.

The export trade from Hull is more interesting than usual. For the eleven months the weight sent from Hull to foreign markets was 1,470,908 tons, against 1,442,365 tons. The difference, being increase, is not large—25,543 tons—but it is remarkable when one considers that in the eleven months the trade with the United States was only 2734 tons, as compared with 120,274 tons for the corresponding period of 1903. The explanation, of course, is that last year the United States manufacturers were troubled by labour disputes in their coalfield, and had to seek supplies from other sources. That under these circumstances there should be an increase in the total is due to the larger quantities taken by other markets—Sweden, North Russia, Germany, Holland, Italy, Belgium, Egypt, West Indies, &c. The exports for the month amounted to 144,672 tons, against 91,556 tons for November of 1903. North Russia has advanced from 10,201 tons to 26,241 tons; Sweden, from 27,898 tons to 49,034 tons; Holland, from 7431 tons to 12,766 tons; Germany, from 20,608 tons to 23,229 tons; Turkey, from 390 tons to 1969 tons; Belgium, from 3299 tons to 4809 tons; while South America, Egypt, and Malta, to which markets nothing was sent a year ago, are once more buyers of Yorkshire coal.

The distinct improvement noted in iron in other parts of the country is not quite so marked in Sheffield. Prices are undoubtedly firmer, and in the case of Lincolnshire iron have appreciably advanced, but the advance is stated not to be warranted by any pressure from Sheffield and neighbourhood. A fair amount of work is reported in the heavy steel manufacturing departments, but a good deal more could be done In railway material. The orders from the home companies continue disappointingly small. The work in hand is more for wagon building and owning firms than for the railway companies. Colliery specialities are in average request, owing to the generally satisfactory state of the coal trade, and extensions proceeding in various coalfields. The South African market is expected to yield better results in the immediate future, and the Sheffield manufacturers are making every preparation to meet such demands as may be made upon them. At present there is a fair amount of work being done in mining machinery and tools for the Transvaal and other districts.

The season trade in cutlery and plated goods is now practically completed. It has not been quite so heavy as was anticipated, though larger than last year. The demand has been mainly on metropolitan account, and for some of the more important provincial centres. The rapid advances in ivory have been a serious factor in the cutlery departments, and as the supplies coming forward for the London sales next January are not large, no relief is expected there.

At the meeting of the Yorkshire branch of the National Association of Colliery Managers, held at Sheffield on the 8th inst., the following gentlemen were elected members:—Mr. G. B. Stones, Carlton Main, near Barnsley; Mr. Albert Riley, Stubley Collieries, Dronfield; Mr. Herbert Ormunde Bishop, Tinsley Park Colliery, Sheffield; Mr. Edward Isaac, Chickenley Heath, near Dewsbury; and Mr Richard Spencer, Altofts.

Mr. W. H. Dixon, secretary of the Hadfield Steel Foundry Company, Limited, has been appointed a director. Mr. Dixon, who has been seventeen years with Messrs. Hadfield, is well known and highly esteemed in Sheffield. He has been most indefatigable in his devotion to the interests of the country, and his promotion, which is thoroughly deserved, has given much gratification in business and other circles.

The Sheffield City Council, having applied for sanction to borrow close upon £300,000 for new works of sewage disposal and sewerage, the Local Government Board deputed Mr. A. A. G. Malet, M. Inst. C.E., and Dr. Theodore Thomson, to hold a public inquiry and receive evidence on the subject. The inquiry was held on the 13th and 14th inst., and the inspectors will now report the result to the Board.

At the meeting of the Sheffield City Council on the 14th inst., Mr. George H. Carmichael, A.M.I.C.E., of Darlington, on the recommendation of the Water Committee, was appointed resident engineer of the Rivelin Water Tunnel Works, at a salary of £400 per annum.

NORTH OF ENGLAND.

(From our own Correspondent.)

IT is most satisfactory to be able to report that the improvement in demand and prices is no longer confined to the pig iron trade, for in the finished branches of the iron and steel industries, and also in shipbuilding, there has also appeared a turn for the better, and with more foundation than was the case when pig iron began to rise. No one who moves much in commercial circles in this district can fail to note the more sanguine tone, and what is more, the increase in the number of orders given out. Almost every trader is inclined to take a distinctly "bullish" view of the prospects for next year, and consumers are beginning to buy more freely than at any time this year, for they have now no reason to believe that they will be the gainers by holding off any longer, seeing that prices are more likely to advance than to recede. They are thus buying to make sure of getting the iron or steel at present prices. Thus, manufacturers this month have booked good orders for execution over a good part of the next half year, and this has led to a general tendency upwards in prices, and, indeed, to some actual advances. Consumers think they cannot get far wrong in placing orders at the present time.

The shipbuilders have been compelled to advance their quotations for new vessels by something like 10 per cent., on account of the increasing cost of materials. That has brought out a number of wavering owners, for they do not see much chance of prices being lowered again, seeing that the producers of materials are in a position to maintain their higher prices, there being comparatively little competition now at home; and in the steel trade of America, which has "dumped" some shipbuilding steel into this district, there seems to be what may be looked upon as a genuine revival. That strengthens the position of platemakers here, and the rise in prices which they have made within the last few days is fully justified. It is true that neither the season of the year nor the condition of the freight markets at present favour the giving out of orders for new steamers, but owners do not want to lose the opportunity of securing cheap vessels. Thus, there are more inquiries received by shipbuilders, and more transactions completed, than for several months, so that they will enter upon the new year in a more favourable position than they expected a short time ago. Messrs. Swan, Hunter and Wigham Richardson, Wallsend-on-Tyne, have secured the order for a 4600-ton steamer for Messrs. E. J. Sutton and Co., of Newcastle, and Messrs. Wood, Skinner and Co. have booked a contract for a 1000-ton cargo steamer. Messrs. William Doxford and Sons, on the Wear, have booked further orders for their turret-decked vessels from Messrs. B. J. Sutherland and Co., of Newcastle.

This improvement in shipbuilding has had a good effect in the engineering industry, though it has not suffered from the depression to anything like the same extent as shipbuilding, the general engineering works having had a very fair share of business all the year, more especially the bridge builders; indeed, as a rule, they have little to complain of with regard to 1904. An official inquiry has been made by the Mayor of Darlington as to the state of trade in that town, and as a rule the firms write very hopefully, while they are generally employing more men than at this time last year, and mostly they are on full time. This is a more favourable condition of affairs than had been looked for. Messrs. Parsons' Marine Steam Turbine Company, Wallsend-on-Tyne, have completed the turbine machinery—the most powerful yet built—for the new Allan liner Virginian, and it will be sent round to Glasgow by sea to be fitted on board.

The tendency is upward in the prices of manufactured iron and steel—in fact, the steel plate makers, who have kept their quotations unchanged from February last, have increased their prices 2s. 6d. per ton, steel ship plates being now at £5 15s., less 2½ per cent., and this has caused the shipbuilders to be so keen about buying that a further advance may be looked for when the syndicate next meets. The rise is justified by the better demand, as well as by the increased cost of production, caused by the higher rates asked for hematite pig iron, and the probability that these will be still further raised. Iron ship plates have been kept at £6, less 2½ per cent. The advance of steel ship angles to £5 5s., less 2½ per cent., is well maintained, and iron ship angles are at £6 2s. 6d., less 2½ per cent.

A strong revival has appeared in the galvanised sheet trade on both home and export account, and sellers are asking 2s. 6d. per ton more than the prices which have ruled for some time. Galvanised corrugated sheets, 24 gauge, are now at £10 7s. 6d., whether of iron or steel. Black sheets are also in more request, and sales are reported at £7 5s. for singles. Orders for joists are increasing in number, and works producing them are well employed. Heavy steel rails have not been altered in price—£4 10s. net being the regular quotation—but owing to the advance in pig iron it has been necessary to raise the price of cast iron railway chairs to £3 10s. net at works—2s. 6d. up. Iron bars have continued unchanged in price all the year, but an advance is imminent.

The "gamble" in Cleveland warrants is still in progress, but it is not so keen as it was, the downward movement in prices which took place last week having choked off a good many outsiders who were having a "flutter." The drop was checked when about 2s. of the rise had been lost, and prices are on the way up this week. Very few expected that the end of the gamble had arrived, for it was recognised that the fall was caused simply by some of the operators selling out to secure profits. Such downward movements in prices are looked for at intervals in such times as these. It is believed that these speculative operations will be continued for some time, and the improvement which has appeared in the finished iron and steel trades will strengthen the position. Some experienced members of the trade would not be surprised to see the speculation in warrants kept up till the spring, in which case increased trade would probably maintain prices. Last week 48s. 9d. cash was secured for Cleveland warrants, but they have since fallen to 46s. 11d. cash; a recovery to 47s. 6d. has taken taken place this week.

Makers who were able to get 48s. per ton for No. 3 Cleveland pig iron have sold this week at 47s.; but 47s. 3d. has been their regular price. Producers lately have been endeavouring to get a greater proportion of No. 3 pig iron out of their furnaces, as that quality realised relatively so much better a price than other qualities. These latter, therefore, are not so plentiful as they were, and have come up nearer to No. 3 in value than they were in October and November. No. 4 foundry is at 46s.; No. 4 forge at 44s. 9d.; mottled at 43s. 9d.; and white at 43s. per ton.

The hematite iron trade becomes steadily more favourable to makers, and it is satisfactory that the improvement is due scarcely at all to speculation. The steel manufacturers are buying rather freely, and the cost of materials is going up, both these circumstances justifying higher rates for the pig iron. During the last few weeks there has been a rise of 4s. per ton in the price of hematite iron, and mixed numbers have this week been sold generally at 53s. 6d. per ton, and some firms have got even 54s. No. 1 is at 54s., and No. 4 at 50s. Rubio ore is dearer; at the close of November it could be bought at 14s. 6d. c.i.f. Tees, now at least 15s. 1½d. has to be paid, owing, in a great measure, to the advances made by the Spanish mineowners. For coke ironmasters have to pay 6d. to 9d. per ton more for next half-year's delivery than the figures of the expiring contracts.

It is satisfactory, after several months of declining shipments, to note an improvement, Scotland taking a good deal more. That tends to strengthen the pig iron market. The quantity shipped this month has been 39,540 tons, as compared with 30,295 tons last month, and 34,568 tons in December, 1903—all to 14th. The stock of Cleveland iron in the public warrant stores continues to increase rapidly. Five months ago 78,013 tons only were held; now the quantity is 165,543 tons, and this month's increase already is 15,943 tons. For that large increase the gamble in pig iron is solely responsible. Certainly, so much would not have been sent in if the price of warrants had not been so much higher than that of makers' iron.

At the annual meeting of the shareholders of Dorman, Long, and Co., Limited, Middlesbrough, the chairman had to report several difficulties in connection with the new machinery that had been laid down both at their Britannia and Clarence Steel Works. It had been decided at Britannia to replace the old mill engine with a more powerful one, but the directors did not propose to lay off the Britannia mills for this until the Clarence mill had been re-started. At Clarence they had met with the same difficulties as at Britannia, and the alteration of the mill was commenced last August. This, it is expected, will be completed by the beginning of February, when work will be re-commenced, and the directors hope to manufacture rails, billets, angles, joists, &c., at very low cost. The constructional branch had been well and profitably employed, and the output had been increased by 50 per cent., while many economies had been effected in the manufacture. The Colonial branches—in Australia and South Africa—had not had a prosperous year. The chairman spoke hopefully about prospects of business for next year, and stated that there were many signs of improvement.

It will be heard with regret that Sir Lowthian Bell, Bart., F.R.S., who is now in his eighty-ninth year, is ill. A few weeks ago he successfully underwent an operation for cataract. Sir Lowthian was one of the founders of the Cleveland iron trade, and he and Mr. W. R. J. Hopkins are the only ones left of the pioneers of that industry.

The coal trade is steady, even in the steam coal branch, which is generally at its worst at this period of the year. From the prices that are agreed upon for next half-year, it is evident that lower prices are not looked for, in fact they point to higher figures. For delivery in next Baltic season, 9s. 6d. f.o.b. has been agreed upon for best steam coal, and 4s. 6d. for smalls, while prompt prices are 6d. below these rates. Best gas is at 8s. 3d. f.o.b. Coke prices are moving up, 14s. 9d. per ton being readily paid for medium qualities delivered at Middlesbrough furnaces, which is 1s. better than the minimum price of this year, and 6d. to 9s. more than present half-year's contracts were placed at.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been a good deal of activity in pig iron warrants during the past week, but prices have been irregular. Towards the close of last week Cleveland warrants dropped 1s. per ton, and although there was afterwards a fair recovery, prices continue to fluctuate. The market seems to be affected by rather less encouraging reports that come from America, and, as the demand on the part of home consumers is limited, the course of business is largely controlled by speculative influences.

Business has been done in Cleveland warrants from 47s. 11½d. to 47s. 3d. cash, and 47s. 11d. to 47s. 8d. one month. Scotch warrants are quoted 53s. to 52s. 3d., and Cumberland hematite 55s. 7½d. per ton.

Prices of Scotch makers' iron are well maintained. G.M.B. No. 1 is quoted at Glasgow 54s.; No. 3, 51s.; Carnbroe, No. 1, 55s.; No. 3, 52s.; Clyde, No. 1, 57s. 6d.; No. 3, 52s. 6d.; Gartsherrie, No. 1, 58s.; No. 3, 52s. 6d.; Summerlee, No. 1, 58s. 6d.; No. 3, 53s.; Langloan, No. 1, 64s.; No. 3, 54s.; Coltness, No. 1, 64s.; No. 3, 54s.; Glengarnock, at Ardrossan, No. 1, 58s.; No. 3, 52s.; Eglinton, at Ardrossan or Troon, No. 1, 53s. 6d.; No. 3, 51s.; Dalmellington, at Ayr, No. 1, 53s.; No. 3, 50s.; Shotts, at Leith, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Carron, at Grangemouth, No. 1, 58s. 6d.; No. 3, 53s. per ton.

There has been a fair demand for Scotch iron for home use, but the export trade is poor.

Scotch hematite pig iron is in good demand, and merchants quote 58s. 6d. per ton for delivery at the West of Scotland steel works.

There are 85 furnaces in blast in Scotland, compared with 86 at this time last year, and of the total 41 are making ordinary, 38 hematite, and 6 basic iron.

The stock of pig iron in Glasgow warrant stores shows an increase for the past week of 252 tons, and now amounts in the aggregate to 10,322 tons.

The shipments of pig iron from Scottish ports in the past week amounted to 4168 tons, compared with 4461 in the corresponding week. There was despatched to India 10 tons, Australia 110, France 100, Italy 130, Germany 131, Holland 235, Spain and Portugal 140, China and Japan 150, other countries 211; the coastwise shipments being 2951 tons, against 3447 in the corresponding week of last year.

The arrivals of Middlesbrough pigs at Grangemouth in the past week amounted to 10,140 tons, compared with 11,130 in the corresponding week, showing a decrease of 990 tons.

The finished iron and steel trades have, generally speaking, fair employment; but they have not improved as might have been expected, considering the very material advance in warrants. It is to be feared, indeed, that the increase in price referred to has embarrassed the manufacturing trade to quite as great an extent as it has benefited it, owing to the difficulty of raising the prices of manufactured goods. Advances in these rates have, of course, become imperative, and, in addition to several already reported in the last two or three weeks, the makers of sheets have this week raised the price of heavy gauges 2s. 6d. per ton. Competition from abroad seems to be somewhat less active at the moment, but manufacturers have still plenty of room for additional orders.

There are inquiries in the market for considerable quantities of

cast iron pipes and other materials, and it is hoped that work of this description may increase.

The coal trade has been fairly employed this week in the inland branch, but shipments have not been so satisfactory. The clearances at the Scottish ports in the past week reached 225,063 tons, compared with 256,117 in the preceding week, and 230,449 in the corresponding week of last year. Main coal is quoted f.o b. at Glasgow 7s. to 7s. 6d., ell 8s. 3d. to 8s. 9d., splint 8s. 6d. to 9s., and steam 8s. 6d. to 8s. 9d. per ton. It is reported that in the inland department of the trade the coalmasters have not generally been able to obtain the advance of 1s. in price that they intimated at the beginning of the month. The explanation of this is that, with the recurrence of open weather, the supplies from the collieries are larger, and competition has accordingly been more keen.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

AFTER rather a dull week in steam coal, there has been a decided change for the better in the Cardiff coalfield. At the docks on Monday the shipments of coal exceeded 55,000 tons, and on Tuesday something like the old state of things occurred, thirty-six steamers being despatched with about 85,000 tons. Some of the cargoes this week have been of large size, 5400 going to Hongkong, and 9000 tons in two cargoes to Port Said. Among the clearances on Tuesday, one of 5400 tons went to Venice, five over 4000 tons, and fourteen between 2000 and 4000 tons; ten cargoes went to France.

Swansea also showed improvement by despatching 54,642 tons of coal and 17,000 tons of patent fuel. With regard to the latter item the trade is considered sound, and the falling off of late in shipments due to the lack of tonnage. Newport would have done better but for the weather; as it was, 45,630 tons went foreign, and 31,325 tons coastwise.

After my despatch last week the Captain W. Menzell was allowed to leave in ballast for Hamburg, but without cargo, and no hindrance was offered to the clearing of the Bengali from Barry. Admiralty contracts for steam coal have been placed, but no definite information as to quantity and price has been given on 'Change, the merchants whose tenders have been accepted being pledged to secrecy. It was noted this week that the Madrid-Saragossa Railway is in the market for 60,000 tons of coal, to be delivered the first half of 1905; also the Cie Générale Transatlantique. Arrangements are being made by the latter for 200,000 tons.

The latest report from 'Change, Cardiff, is that best large steam, referred to as best Admiralty coals, and also seconds, are in better demand. Small steam coals are in abundance, and quotations as low as 7s. to 7s. 3d. common. Dry coals are rather weak, and prices fluctuating; house coals firm, and late quotations well maintained. Rhondda No. 3 and also small are in good request.

Closing figures Cardiff as follows:—Best large steam, 13s. 3d. to 13s. 6d.; best seconds, 12s. 9d. to 13s.; seconds, 11s. 6d. to 12s.; drys, 11s. 9d. to 12s. 3d.; best smalls, 7s.; best ordinaries, 6s. 3d. to 6s. 6d.; seconds, 5s. 9d. to 6s.; inferiors, including drys, from 5s. 6d. Monmouthshire semi-bituminous: Best large, 11s. 6d. to 11s. 9d.; best ordinaries, 11s. 3d. to 11s. 6d.; seconds, 10s. 3d. to 10s. 9d. House coal: Best, 16s. 6d. to 17s.; best ordinaries, 13s. 6d. to 14s. 6d.; seconds and other kinds, 10s. 6d. to 13s. No. 3 Rhondda, 13s. 3d. to 13s. 6d.; brush, 11s. 6d. to 11s. 9d.; small, 9s. 6d. No. 2 Rhondda, 9s. 9d.; through, 8s. 3d. to 8s. 6d.; small, 6s. 6d. to 6s. 9d. Patent fuel, 12s. 6d. to 13s., firm. Coke: Furnace, 16s. to 16s. 6d.; foundry, 18s. to 18s. 3d., and special, 20s. to 21s. 6d. Both in coke and patent fuel prices are firm and business improving. In pitwood the arrival of large cargoes of French and Portuguese timber has lowered prices a few pence; yet, on the whole, quotations are firm, and best commands 17s. 6d. to 17s. 9d. Cardiff, while Newport quotes 18s., and Swansea 19s. 6d. into truck.

Swansea, while admitting colliery improvement, continues to suffer from depression and temporary stoppages. Anthracite shows more vigour, but is open to improvement, though little free coal is said to be on offer for this month. Nuts are in request; also cobbles. Culm remains weak. Latest prices are:—Steam coal, 12s. 6d. to 13s.; No. 3 Rhondda, 13s. 6d. to 13s. 9d. Patent fuel, 11s. 6d. to 11s. 9d. In anthracite closing prices were:—Best malting, 20s. to 21s.; seconds, 17s.; big vein, 12s. to 12s. 3d.; red vein, 10s.; cobbles, 17s. to 17s. 6d.; nuts, 18s. to 20s.; peas, 11s. to 12s.; rubbly culm, 4s. 6d.; duff, 4s.

The Western collieries continue a fair amount of trade with Ireland, and this is also to be noted in connection with Newport. One day this week seven vessels left latter port for Wexford and other quarters.

Swansea trade with France last week was brisk, nearly 20,000 tons leaving Cardiff.

Taking the year so far, the coal shipments to France have shown an increase of 2000 tons, but the tax on small has been a great evil to the port. This was strongly expressed at the last harbour meeting.

In connection with railway enterprise the Cardiff railway contract for the line from Taffs Well to Treforest has been secured by Oliver and Sons, contractors, Victoria-street, Westminster. The estimated cost is £250,000. The Rhymney Railway management is proceeding with the construction of a new branch line from Ystrad Mynach towards the Fochrhiw collieries of the Dowlais Company. This will enable the Powell Duffryn Company to develop the minerals underlying Penallta Farm. The new collieries are to be equipped with the most modern plant. The Barry extension to connect with the Brecon is expected to join on the 2nd January. In anticipation of this the Brecon line has been widened up to Maclaren, pit No. 1, which is within a mile of the Rhymney Station of the Brecon and Merthyr line.

Railway and colliery developments are being carried on very satisfactorily, and in unison.

Confident hopes are held out regarding the Aberystwith and Aberayrow railway promotion.

The buoyancy of the tin-plate trade shows no sign of abatement. Last week 94,498 boxes were sent from works and 130,960 boxes were shipped, leaving stocks down to 107,221 boxes.

At the harbour meeting in Swansea this week, it was remarked that this month the trade has shown an increase to the extent of 52 per cent. Sir J. J. Jenkins stated that to the end of November they had shipped more tin, terne, and galvanised plates than at any period in the history of Great Britain.

Referring to the dumping of German and American steel into Wales, Mr. D. A. Thomas, at a Newport meeting, stated this week that dumping had been of marked benefit to Newport industries, but had admittedly injuriously affected the Dowlais district. During this week four important cargoes came into Newport: 1166 tons from Antwerp, 980 tons from Rotterdam on one date, 1650 from Antwerp and 507 from Rotterdam on another.

The imports of pig have included 1200 tons from Millom, and in Spanish ore 4000 tons for Blaenavon. In manganese, from Rio, 5000 tons came to Pyle and Blaina.

Pig iron prices have receded—Scotch 3d., Middlesbrough 1s., and hematite 9d.

On 'Change, Swansea, this week, the price of finished iron and steel was reported as favourable, steel bars showing an upward tendency. Consumption decidedly on the increase.

In tin-plates higher prices are being given for spot lots and prompt delivery.

Closing prices as follows:—Pig iron: Glasgow warrants, 52s.; Middlesbrough No. 3, 47s. 6½d.; hematite warrants, 55s.; Welsh bars, £6 2s. 6d. Sheet iron, £8 5s. to £8 10s.; steel, £8 2s. 6d. to £8 5s.; steel rails—heavy sections, £4 10s. to £4 12s. 6d.; light, £5 10s. to £5 12s. 6d.

Bessemer steel tin-plate bars, £4 5s.; Siemens best, £4 7s. 6d.

Tin-plates: Bessemer steel coke, 12s. 9d. to 13s.; Siemens coke, 13s. to 13s. 3d.; ternes, per double box, 28 × 20 C, 23s. 6d. to 25s. 6d.; best charcoal, 14s. 6d. to 15s.; big sheets for galvanising, 6ft. by 3ft. by 30 g., per ton, £9 to £9 5s.; finished black plate, £8 17s. 6d. to £9 2s. 6d.

Block tin, £131 10s.; spelter, £25. Lead, £13 2s. 6d. Copper, £65 12s. 6d. Iron ore: Rubio, 14s.

A nail rod combine is announced between thirty of the leading firms in the United Kingdom, with a view of stopping underselling.

I hear that it has been decided to retain the Midland sliding-scale.

In the Midland districts this week it was stated that an agent in German steel had been directed to advance 2s. 6d. per ton, making 85s. per ton delivered for steel billets, and 87s. 6d. for sheet bar. It is rumoured that Germany is buying on Russian orders.

At Dowlais business is satisfactory, and No. 19 blast furnace is once again at work.

In harmony with tin-plate briskness steel make in the Swansea Valley is improved.

NOTES FROM GERMANY.

(From our own Correspondent.)

A FAIR activity has been maintained in the principal trades of the iron industry over here, and the tone all round is pretty firm. Material changes, or improvements, that would influence the condition of the iron business have not, however, been noticeable upon the week.

Specifications and inquiries have increased on the Silesian iron market; the position generally is healthy and firm, and the resolve of the Upper Silesian works to accept orders for bars and hoops for exposed districts at raised quotations only, and not for a later period than the first quarter next year, has rather tended to increase the stiffness in quotations. Export, on the whole, has been developing satisfactorily. Girders are in fairly good request, considering the time of the year; the rail works are vigorously occupied, and for sheets a comparatively brisk demand was experienced. At the plate mills employment has slightly increased against previous weeks.

There was more confidence shown in the iron and steel industry of Rheinland-Westphalia, and the amount of work secured during the week, though not heavy, will be sufficient to keep the majority of the mills in steady occupation. There has been very little life stirring in the heavy plate trade, which is owing to the uncertainty that prevails with regard to the prolongation of the Heavy Plate Convention. The condition of the sheet trade, on the other hand, has been a trifle more favourable, and prospects are considered fair.

On the 12th inst. a meeting of the Wire Nail Convention will take place in Berlin, for the purpose of taking final measures with regard to the prolongation of the Convention.

The joint stock company, Krupp-Essen, is reported to be vigorously engaged for some time past on shipbuilding material. Both Russia and Japan are said to have sent in heavy orders for armour plates and guns.

Dealers, as well as industrial establishments, bought coal pretty freely last week on the Silesian market. Small coal has even been getting scarce, on account of the strong demand that comes in from the sugar mills. The situation of the coke market is favourable, all sorts meeting with good request.

The consumption in coal has improved in Rheinland-Westphalia. The business to South Germany has considerably increased, and exports to France have been lively. Gas coal as well as steam coal are in strong request, and dry sorts, too, have been selling fairly well. Shipments in coke and briquettes have increased.

Concerning the iron and mining industry in the three districts of Lorraine, it has been officially stated that in the Metz district 20 iron ore works, 7 blast furnace works with 32 blast furnaces, 6 iron foundries, 3 steel works and 3 malleable iron works have been in operation in 1903. The total production was 6,234,717 t. iron ore, 1,383,559 t. pig iron, 24,879 t. foundry pig, 42,089 t. forge pig, and 742,169 t. steel.

In the Diedenhofen district 23 iron ore mines, 5 blast furnace works with 14 blast furnaces, 1 iron foundry and 1 steel works have been in operation, the total production being 447,785 t. iron ore, 590,426 t. pig iron, 5593 t. foundry pig, and 215,397 t. basic. In the Saargemünd district 3 iron foundries, 3 malleable ironworks and 2 steel works, 3 collieries and 8 salt mines have been in operation; production was 389 t. foundry pig, 8305 t. forge pig, 3979 t. basic, 1,583,272 t. pit coal, and 60,278 t. salt.

Pig iron is in fair demand in Austria-Hungary. Bars and sectional iron have also been in good request. The agreement between the Iron Syndicate and the Upper Silesian Steel Convention concerning protection in the mutual districts of sale, has been prolonged for 1905. The offers of the United Rail Works, regarding the three years' requirements in rails for the State Railways, have been refused by the Railway Minister, who declined to accept prices that were about 5 per cent. higher than those previously noted. The Rail Works have now been requested to send in offers for the five years' requirements at the prices formerly ruling.

Sheets are in fairly good request, while plates remain neglected. The wagon shops that continue but indifferently occupied have been invited to tender for the supply of 64 wagons, worth 298,000 crowns.

There has been generally a little more life shown in the coal and coke trade of Austria-Hungary during the past week. The Union of Coal Dealers raised the prices of sale 6 heller per 100 kilos. from the 1st inst.; coal in bags, however, is to be sold at the former price of 2·70 crowns per 100 kilos.

Demand and sale on the Belgian iron market have not improved, and the condition all round is much as previously reported, only for rails and girders the international prices have been fixed. Bars are without animation.

Engine coal is in lively request in Belgium, whereas all classes of house fuel remain quiet.

The position of the French iron market generally has shown no improvement since previous reports, and must be considered as rather unsatisfactory, as only the large works in the Department Haute-Marne and Loire can be stated to be well employed. The Paris iron market is dull.

There was but a moderate trade done in coal and coke on the French market, and the tone all round is a trifle depressed, demand and sales being lower than is expected at this time of the year.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, November 30th.

THE most interesting feature of the copper market to-day is reduction of stocks, the amount of which is now put at 50,000 tons. Copper has been in extraordinary demand during the past two months, as much as 150,000 tons having been sold during those months. Prices have accordingly advanced, and electrolitic is now quoted at 15 dols. The production of copper during the first eleven months is stated to have been 387,225 tons, of which 73,000 tons were imported. The total foreign shipments for eleven months are 225,344 tons, including 20,000 tons exported during the month of November. The estimated domestic consumption for eleven months is 192,000 tons; total domestic and foreign consumption for that time 417,344 tons, which shows that the market has called for 30,019 tons more than current production. The present estimated reserve stock of about 50,000 tons will practically disappear within a month. In fact, this amount of copper is now under contract for shipment. As consumption is now in excess of production, the only reasonable thing to conclude is that copper will go higher. Lake copper is quotable at 15 to 15½ cents; casting grades, 14¼ to 14⅝ cents, f.o.b. shipment, in New York. Every effort is being made to increase the production of copper, and the present activity will stimulate the opening up of several promising copper properties in various localities. Tin has met with a sharp advance, and arrivals for the past week were 598 tons, and for the month 1725 tons; afloat, 2145 tons.

The steel market is in a somewhat excited condition over a phenomenal demand for finished steel and iron for all manner of purposes. Crude iron is in very active demand; the sales for the past week in this market footing up about 60,000 tons, mostly foundry grades. There are also large orders coming into western pig iron centres, causing an upward movement in prices varying from 50c. to 75c. Bridge iron is also now being contracted for, to be furnished as soon as the mills can make it, for winter bridge construction. In the North-West the railroad companies have become large buyers of material, both for bridge work and for rolling stock; and the car building plants have secured very heavy orders for cars, including steel cars, in which the large steel car building plants are overcrowded. There is also a very lively time in other kinds of steel, including merchant steel, tool steel, and crucible, as well as in plate steel for boiler and tank work and for car building. The general tone of the market is decidedly strong. The worst feature of the case is such an upward tendency as will induce the large consuming interests to curtail their requirements. Manufacturing interests everywhere recognise this possibility, and are endeavouring to guard themselves against the threatened danger. Makers of furnace and mill products are not seeking to take advantage of their customers, and will endeavour to supply all incoming wants as promptly as possible, and practically close to present prices. Lake ores are strong, and may be further advanced. A wise and far-sighted policy would prevent such sudden twists in the market as this. It has been frequently mentioned that the American markets carry practically no stock, and that when sudden movements come prices are artificially advanced, because of the scramble for supplies for immediate delivery. Coal production is being stimulated because of the general increase in building activity. Coke production is also being increased to supply the growing needs of coke users.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market is in better demand, tonnage having come on. Prices unchanged. House coal in fair demand, prices remain firm. The quantity of coal shipped for week ending 10th was 76,995 tons—foreign, 46,630 tons; coastwise, 31,325 tons. Imports for week ending 13th:—Iron ore, 9700 tons; bars, 4603 tons; Manganese ore, 5000 tons; pig iron, 1696 tons; scrap, 300 tons; pitwood, 1944 loads; deals, &c., 1177 loads.

Coal—Best steam, 11s. 6d. to 11s. 9d.; seconds, 10s. 6d. to 10s. 9d.; house coal, best, 15s.; dock screenings, 6s. 3d.; colliery small, 5s. 9d. to 6s.; smiths' coal, 9s. Pig iron—Scotch warrants, 52s. 6d.; Middlesbrough No. 3, 47s. 6d.; Middlesbrough hematite, 55s. Iron ore—Rubio, 14s. to 14s. 6d.; Tafna, 15s. to 15s. 6d. Steel—Rails, heavy sections, £4 10s. to £4 12s. 6d.; light ditto, £5 10s. to £5 12s. 6d.; Bessemer steel tin-plate bars, £4 5s.; Siemens steel tin-plate bars, £4 7s. 6d., all delivered in the district, cash. Tin-plates—Bessemer steel, coke, 12s. 9d. to 13s.; Siemens, coke finish, 13s. to 13s. 3d. Pitwood—18s., ex ship. London Exchange telegrams—Copper, £65 12s. 6d. to £65 15s.; Straits tin, £132 to £132 5s.

Freights active, rates unaltered.

SOCIETY OF ENGINEERS.

THE fiftieth annual general meeting of the Society of Engineers was held on Monday, December 12th, 1904, at the offices of the Society, 17, Victoria-street, Westminster. The chair was occupied by Mr. D. B. Butler, President. The gentlemen whose names are given below were duly elected by ballot, as the Council and officers for 1905, viz.:—As President, Mr. Nicholas James West; as Vice-presidents, Messrs. Maurice Wilson, Richard St. George Moore, and Joseph William Wilson; as ordinary members of Council, Messrs. Joseph Bernays, George Abraham Goodwin, George Green, William Henry Holttum, Edward John Silcock, Diogo Andrew Symons, John Aird, and Alexander Graham Drury; as honorary secretary and treasurer, Mr. George Burt; as honorary auditor, Mr. Samuel Wood, F.C.A. The President announced that the following premiums had been awarded by the Council for papers read during the past session, viz.:—The President's gold medal to Mr. William Edward Storey for his paper on "Condensing Machinery;" the Bessemer premium of books to Mr. R. G. Allanson-Winn for his paper on "Deep Sea Erosion and Foreshore Protection;" a Society's premium of books to Mr. A. S. E. Akermann for his paper on "British and American Coal-cutting Machines;" and a Society's premium of books to Mr. Frank Latham for his paper on "Some Recent Works of Water Supply at Penzance." The fiftieth annual dinner of the Society was held at the Hotel Cecil on Wednesday evening, and was a great success. Among the principal guests were Sir John Colomb, who responded to the toast of the "Imperial Forces of the Crown;" Sir W. Christie, who proposed the "Society of Engineers;" and Sir William H. White, who acknowledged the toast of "Kindred Institutions," proposed by the President-elect, Mr. Nicholas J. West. There were naturally several allusions to the jubilee of the Society, but its actual birthday was in May, 1854, when Messrs. R. M. Christie, H. P. Stephenson, and A. Williams, students of the Putney College—one of the earliest engineering colleges—founded the Putney Club. In 1857, at a general meeting on December 7th, the club was renamed the Society of Engineers, and, as the membership had then risen to fifty-four, it was necessary to engage a committee-room in Exeter Hall for the meetings, which in course of time was also found too small, the lower hall being then taken, and used for many years. In 1865 honorary members were first elected, and amongst the earliest names are found Sir William Fairbairn, Sir John Herschel, Sir Joseph Whitworth, Dr. Percy, and Professor Rankine. The ordinary membership of the Society, with a few retrograde steps, has, as a whole, advanced, and now includes 555 members and associates, and, as the present year has seen some additions to the *rôle*, it is evident that this, the oldest engineering society, save three, in the country, is still full of strength and activity. One of the toasts most heartily honoured was that of Mr. Perry F. Nursey, the secretary of the Society, who has been with it from its early days, and has served it well in all official capacities.

MANAGERS OF SEWAGE WORKS.—The Association of Managers of Sewage Disposal Works held its third annual dinner on Thursday, the 8th inst., at the Holborn Restaurant. The annual general business meeting had taken place earlier in the day. This Society had for its first president Dr. Rideal. Then Mr. W. D. Scott-Moncrieff held office for two consecutive years, and the newly-elected president is Mr. Baldwin Latham. Such a list of names bears evidence to the fact that the aims of the Association meet with approval in influential quarters. Indeed, it is not too much to say that a great deal of good has been and is continually being done by the interchange of ideas and experiences by the number of practical men thus brought into touch with one another. The dinner was a great success, and the gathering was largely representative. We understand that the number of members is well over the hundred, and that the Association is in a prosperous condition. It is to be congratulated in having secured Mr. Baldwin Latham as its president for the coming year.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

29th November, 1904.

25,991. DISINTEGRATOR for SUCTION DREDGERS, O. Imray.—(*A. F. Smulders, Holland.*)
25,992. FITTINGS for THEATRE SEATS, S. W. V. Nostran, London.
25,993. LIFE-SAVING APPARATUS, J. Herzog, London.
25,994. MACHINES for PRINTING TICKETS, J. Goebel, London.
25,995. SEWING MACHINES. G. B. Ellis.—(*Compagnie des Moulins à Coudre de Coaticook, Canada.*)
25,996. STEERING MECHANISM for MOTOR VEHICLES, Société Anonyme des Automobiles Ariès, London.
25,997. MIXTURE of COAL GAS and WATER GAS, F. Neuman, London.
25,998. MANUFACTURE of DYE-STUFFS, R. B. Ransford.—(*L. Cassella and Co., Germany.*)
25,999. PIPE COUPLINGS, A. H. Hicks, London.
26,000. SHARPENING SAWS, G. Ransom, London.
26,001. BOTTLE SEAL, G. C. Marks.—(*The Champion Seal Company, United States.*)
26,002. VIOLINS, M. B. Hern, London.
26,003. PLUG TAPS, H. E. Walters, London.
26,004. APPARATUS for SUPPLYING BEVERAGES, N. R. Stiles, London.
26,005. TREATING TUBULAR FABRICS, W. R. Smith, London.
26,006. INTERNAL COMBUSTION ENGINES, W. P. Burke, London.
26,007. APPARATUS for MOULDING DOUGH, J. Callow, Liverpool.
26,008. MACHINERY for CRACKING NUTS, B. Magrini, Liverpool.
26,009. SPEED-REGULATING GOVERNORS, J. Callow, Liverpool.
26,010. LAUNDRY APPLIANCE, E. Smith, Liverpool.
26,011. NON-SLIPPING DEVICES for VEHICLE WHEELS, R. H. Gayner, jun., Liverpool.
26,012. MODIFYING APPARATUS for the MOUTH, A. M. Leroux, London.
26,013. CALCULATING MACHINES, A. E. Edwards.—(*B. H. Sanders, United States.*)
26,014. PYJAMA GARMENT, W. O. Lee, New York.
26,015. RAILWAY TIES, A. Dreibelbis, Reading, U.S.A.

30th November, 1904.

26,016. LAMP WICKS, W. S. Rogers, London.
26,017. MACHINES for PERFORATING ROCK, C. Walton and G. H. Rayner, Seascale, Cumberland.
26,018. FRYING-PAN, S. L. Moore, Cardiff.
26,019. HANDLE-BAR for CYCLES, G. S. Fraser, Glasgow.
26,020. CANDLE LAMPS for CYCLES, J. Orme, North Wales.
26,021. STEAM TRAP, G. Laporte, Bolton.
26,022. SWATH TURNERS, J. Hotkirk, Stamford, Lincolnshire.
26,023. PLUMMER BLOCKS, W. Raine and G. W. Kirk, York.
26,024. STIFFENERS for ARTICLES of WEARING APPAREL, E. M. Mountford, Birmingham.
26,025. CABIN HOOKS, A. C. Howell and A. and F. C. Giles, London.
26,026. FISHING-ROD TACKLE, C. Guise and S. Thomas and Sons, Limited, London.
26,027. SHUTTLES for LOOMS, J. W. Cook, Manchester.
26,028. AUTOMATICALLY LOCKING RAILWAY CARRIAGE DOORS, N. Dewhurst, H. T. Griffiths, and J. W. Moore, Halifax.
26,029. FILLING CANS with OIL, A. E. W. Browne, Birmingham.
26,030. WRINGING MACHINES, F. Evans and W. Boote, Stoke-on-Trent.
26,031. COMBINATION in BATHS, C. and A. Hillier, Birmingham.
26,032. BOAT DAVIT, W. Richardson, Sunderland.
26,033. APPLIANCES for CASTING STEREOTYPE PLATES, G. A. Wilson, Liverpool,
26,034. TELEPHONIC INTERCOMMUNICATION, J. Young, London.
26,035. ENABLING the "UNIVERSAL DRAFTING MACHINE" to be used with a "VERTICAL" DRAWING BOARD, A. Miller, jun., London.
26,036. BELT CONVEYORS, M. Blake and R. H. Smart, Glasgow.
26,037. LAMP BURNERS, M. Herrmann and L. Lorenz, Birmingham.
26,038. APPARATUS for CUTTING HOLES, O. Küppers, Leicester.
26,039. COUPLING APPARATUS for VEHICLES, F. Kynman and T. Fairfield, Hull.
26,040. MACHINES for CLEANING BOTTLES, T. Hill, Hull.
26,041. LATHE and BORING MACHINES, W. Keighley, Bradford.
26,042. DOOR FASTENER, R. Bell, Eccles New-road, near Manchester.
26,043. SUBMARINE TELEGRAPHY, I. Kitsee, London.
26,044. LUBRICATORS for VEHICLE WHEELS, T. C. Wild, London.
26,045. PINS for BROOCHES, F. H. Wheway, Birmingham.
26,046. COUPLERS for RAILWAY CARS, L. Lecompte, Glasgow.
26,047. ROCK CUTTER and HOLER, H. J. C. Keymer, Gorleston-on-Sea.
26,048. ACETYLENE LIGHTS, A. F. J. Johnson, London.
26,049. VELOCIPEDES, A. H. P. Blunt, London.
26,050. SINGLE-TRIGGER DOUBLE-BARREL GUNS, F. Beesley, London.
26,051. KNITTING MACHINES, C. H. and E. C. Wynne, London.
26,052. INDICATORS, A. Turner, London.
26,053. KNIFE-CLEANING MACHINE, A. Schindler, London.
26,054. DRAINAGE INTERCEPTOR, H. J. Houghton, J. E. Royall, and E. Houghton, London.
26,055. PLASTIC COMPOSITION, S. Wohle and A. M. Hart, London.
26,056. NEUTRALISING the EFFECTS of VIBRATION in VEHICLES, A. and E. H. Pulbrook, London.
26,057. MANTLES for INCANDESCENT BURNERS, W. H. Owensmith, Handsworth, Staffs.
26,058. POLISHING PADS, M. and E. Springborn, London.
26,059. IMPREGNATION of WOOD, T. D. Lichtenstein, London.
26,060. MEDICAL APPLIANCE, J. Hunter, London.
26,061. BEVEL SQUARE, P. R. J. Willis.—(*J. F. McCormick, United States.*)
26,062. MOSS-CLEANING MACHINES, L. P. Labarthe, and A. J., P. U., and C. J. Simoneaux, Kingston-on-Thames.
26,063. ELECTRIC CURRENT-GENERATING MACHINE, W. S. Frost, London.
26,064. MANUFACTURE of SHOW LETTERS, W. Love, London.
26,065. MACHINERY for MAKING PERFORATED PAPER for PLAYING MUSIC, W. W. Colley, London.
26,066. SELF-DEVELOPING DRY PLATE, W. F. C. Kelly and J. Bentham, London.
26,067. CONSTRUCTION of DOMESTIC WARMER, F. J. Costes, London.
26,068. SASH FATENER, B. Randle, London.
26,069. VENTILATING GEAR, C. E. Batcock and P. W. Ricks, Bexley Heath, Kent.
26,070. BELT CONNECTIONS for MACHINERY, C. Payne, Cranbrook, Kent.
26,071. SECURING BANDS to MACHINERY, J. Gardner and J. Clough, London.
26,072. HEAD COVERINGS, H. Koller, jun., London.
26,073. APPLYING GREASE to COOKING VESSELS, L. Embrey, London.
26,074. APPARATUS for PRODUCTION of GAS, G. T. Galley, London.
26,075. COMPOUND STEAM ENGINES, W. W. and E. G. E. Beaumont, London.
26,076. STEAM FIRE ENGINES, J. C. Hudson, London.
26,077. COVERING of SHIPS' HATCHWAYS, N. E. Porter and T. R. S. Maltby, London.
26,078. ANNULAR BASIN for GASOMETERS, M. Scheuss, London.
26,079. SAFETY-PIN BUTTON, H. R. Arford, London.
26,080. TYPEWRITING MACHINES, C. D. Pozzo, London.
26,081. SEPARATING SILICA from EARTHS, E. Weakes, London.
26,082. DYNAMO CONSTRUCTION, H. Leitner and R. N. Lucas, London.
26,083. SHOEMAKERS' EDGE IRONS, M. F. Lindberg, London.
26,084. MACHINES for TREATING YARN, J. W. Fries, London.
26,085. HOT-WATER HEATING APPLIANCES, J. Botsonnas, London.
26,086. OBTAINING MOTIVE POWER from GASES, A. Vogt, London.
26,087. BAKING OVENS, F. Kempter, London.
26,088. BAKING OVENS, F. Kempter, London.
26,089. MATTRESSES, L. Vanobberghen, London.
26,090. TIRE for WHEELS of ROAD VEHICLES, E. Kingsnorth, London.
26,091. CARBURETTERS for INTERNAL COMBUSTION ENGINES, L. and T. Gautreau, London.
26,092. RECEIVER SWITCHES for TELEPHONE INSTRUMENTS, I. B. Birnbaum and F. G. Bell, London.
26,093. CRUCIBLE STEEL SMELTING FURNACES, R. Lindemann, London.
26,094. TESTING ELECTRIC IGNITION ARRANGEMENTS of INTERNAL COMBUSTION ENGINES, W. P. Burke, London.
26,095. LETTER-CLOSING MACHINE, A. L. H. Neumann, London.
26,096. CONTROLLING SYSTEMS of ELECTRIC MOTORS, A. C. Eastwood, London.
26,097. MAGNETIC CLUTCHES, A. C. Eastwood, London.
26,098. ELECTRIC CURRENT-CONTROLLING SYSTEMS, A. C. Eastwood, London.
26,099. MOTOR-CONTROLLING SYSTEMS, A. C. Eastwood, London.
26,100. REMOVAL of SOOT from FURNACES, O. E. Wilson, London.
26,101. METHOD of SUSPENSION of the DIFFERENTIAL SHAFT of AUTOMOBILE VEHICLES, A.-E. Brillié, London.
26,102. DRYING APPLIANCE for HYDRO-EXTRACTORS, E. L. Lloyd and H. Sutcliffe, London.
26,103. LAMP BURNER, M. Herrmann and L. Lorenz, London.
26,104. CYCLE RIM BRAKES, M. Rüdiger, London.
26,105. APPARATUS for MOISTENING PLATES in COLLOTYPE PRINTING PRESSES, C. Wagner and F. Stange, London.
26,106. MACHINES for STONING OLIVES, A. S. Coupa, London.
26,107. LAMPS, G. Bentote, London.

1st December, 1904.

26,108. KNIFE and FORK DROPPER, H. H. Watts, Wokingham, Berks.
26,109. ROTARY ENGINES and MOTORS, A. Hebden, London.
26,110. STEAM VALVES, J. Sadler, Ramsbottom, near Manchester.
26,111. AUTOMATIC AIR BRAKE RELEASE VALVE, F. E. Keaney, Bowdon, Cheshire.
26,112. DRY SEAT for TRAMCARS, J. Merrill, Sheffield.
26,113. PREPARING PAPER for SKETCHING, J. Linnett, jun., and S. D. Tytler, Coventry.
26,114. REGULATING AIR SUPPLY to INCANDESCENT GAS BURNERS, A. Cashin, Birmingham.
26,115. RESERVOIR PENS, C. P. Lawrence, Newton Rigg, near Penrith, Cumberland.
26,116. LAMPS and STOVES, L. Nissim, Southend-on-Sea, Essex.
26,117. COMPOUND for CLEANING the HANDS, F. S. Brereton, Manchester.
26,118. LOOSE LEAF BINDERS, E. K. Honey, Bristol.
26,119. BACK-PEDALLING BRAKES for CYCLES, F. E. Riddiford, Birmingham.
26,120. ANTI-SKIDDING DEVICE for PNEUMATIC TIRES, E. A. Stretton, Birmingham.
26,121. DEVICE for HOLDING REFILLS in the COVERS of COUNTER BOOKS, H. E. Edmunds and W. Edmunds, Limited, Derby.
26,122. LAPPET LOOMS, W. Strang, Glasgow.
26,123. TREADS for PNEUMATIC TIRES, T. Wood, Manchester.
26,124. ELECTRIC RELEASE MOVEMENT, C. Vincent, London.
26,125. LOCKING DEVICES, F. Nunns, Halifax.
26,126. BEARING REIN of a HORSE'S HARNESS, C. E. Long, Birmingham.
26,127. BAKERS' DRAW-PLATE OVENS, J. B. Cox, Birmingham.
26,128. COUPLINGS for FLEXIBLE PIPES, H. Causer, Birmingham.
26,129. CLOTH-FOLDING APPARATUS, H. H. and T. E. Scharffetter, Manchester.
26,130 SLOTTED SPRING WHEEL for BICYCLES, E. J. Moore, Dublin.
26,131. TARGETS, W. Bailey, Glasgow.
26,132. CANDLESTICKS, D. Davies, Porth, Glam.
26,133. MAKING METALLIC BEDSTEADS, G. H. Bruce, Smethwick.
26,134. REVOLVING SEAT for CHAIRS, A. Peacock, Newcastle-on-Tyne.
26,135. SMALL ARMS, J. B. Thorneycroft, M. G. Farquhar, and A. H. Hill, London.
26,136. AERATING FERMENTING LIQUIDS, A. J. Murphy, London.
26,137. FULL PLATE LEVER PALLET BRIDGE, F. Musgrave and W. Schneider, Lytham, Lancs.
26,138. STEAM TURBINES, P. F. Oddie, London.
26,139. SHOW CASES, J. and E. Curtis, Leeds.
26,140. MANUFACTURE of REVERSIBLE GARMENTS, W. G. Hewlett, Dorchester.
26,141. COMBINATION LOCKET and BRACELET, T. Wilcox, Birmingham.
26,142. WATER GAUGES, O. Heinemann, Berlin, Germany.
26,143. CLIP for ENDLESS ROPE HAULAGE, R. Blackburn, Durham.
26,144. SEWAGE-DISTRIBUTING APPARATUS, E. C. Maccormac, London.
26,145. BAGS, S. Hodgkinson, London.
26,146. EXPLOSIVE COMPOUNDS, Curtis and Harvey, Limited, and A. F. Hargreaves, London.
26,147. SAFETY DEVICE for OIL LAMPS, S. Trivick and M. D. Rucker, London.
26,148. DISTRIBUTING LIQUIDS on ROADS, T. Aitken, London.
26,149. ENABLING a PERSON to SEE BEHIND HIM, A. Larson, London.
26,150. PERIPHERAL STRUCTURES for WHEELS, P. D. Hall, London.
26,151. OIL LAMPS, E. J. Owen, London.
26,152. STREET-SWEEPING MACHINES, J. P. Clark, London.
26,153. SELF-PROPELLING MOTORS, H. P. Saunderson, London.
26,154. SPEED GOVERNOR for STEAM ENGINES, P. Erös and T. Fonyó, London.
26,155. MAKING PATTERNS of PLASTIC MATTERS, E. Schmid, London.
26,156. BEER ECONOMISER, F. Nusch.—(*C. Coudere, France.*)
26,157. ELECTRIC ARC LAMPS, F. Nusch.—(*A. Cotis, France.*)
26,158. STEERING DEVICE for TOBOGGANS, J. Thooft, London.
26,159. BOOTS and SHOES, S. Stophan.—(*J. Schmidt, France.*)
26,160. FOLDING ROCKING CHAIR, G. F. Allen, Walthamstow, Essex.
26,161. ELECTRICAL CIRCUIT BREAKERS, W. S. Toplis, London.
26,162. PACKINGS for FLUID-PRESSURE TURBINES, J. N. Bailey, London.
26,163. POWER-GENERATING MOTOR, H. J. Noonan, Basingtoke, Hants.
26,164. DOOR FASTENING, F. J. J. Gibbons, London.
26,165. BUFFER COUPLINGS for RAILWAY CARRIAGES, J. T. Jepson, London.
26,166. HORSESHOES, P. A. Carré, London.
26,167. THERAPEUTIC PREPARATIONS, J. H. Coulson, London.
26 168. FILTERS for PURIFYING WATER, A. T. Walker, London.
26,169. THERMAL CUT-OUTS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,170. ELECTRIC SWITCHES, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,171. ARMATURE WINDINGS for DYNAMO ELECTRIC MACHINES, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,172. ELECTRIC SWITCHES, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,173. PAPER ARTICLES, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,174. ELECTRIC TRANSFORMERS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,175. ELECTRIC TRANSFORMERS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,176. ELECTRIC TRANSFORMERS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,177. AUTOMATIC CENTRE PUNCHES, F. Spalding, London.
26,178. APPARATUS for PRODUCING GASES, A. Vogt, London.
26,179. ELECTRICALLY-OPERATED PERCUSSIVE DRILLS, P. J. Ogle, London.
26,180. MOTOR AXLES of AUTOMOBILES, J. Spyker, London.
26,181. DISINFECTORS, J. C. Thresh, London.
26,182. BOTTLE-FINISHING MACHINE, J. Munford.—(*L. L. Mount, United States.*)
26,183. FILLING of CANDLE-MOULDING MACHINES, W. Calderwood and W. Mills, London.
26,184. SAFETY GEAR for MINE SKIPS, B. Schlesinger and E. G. Weldon, London.
26,185. ROTARY PUMPS, W. Peck, London.
26,186. CHURN, O. Christensen and C. P. Sölbeck, London.
26,187. MEASURING APPLIANCE for FOOT WEAR, G. Engelhart, London.
26,188. EXPULSION of the WATER of CRYSTALLISATION from METALLIC SALTS, A. H. White, London.
26,189. BROADSIDE UNDER-WATER TORPEDO LAUNCHING APPARATUS, A. E. Jones, London.
26,190. LAMPS, J. A. Middleton, London.
26,191. MACHINES for SPINNING YARN, D. Despradelle and V. Bélanger, London.
26,192. REDUCING the DENSITY of OILS, A. C. di Salsaco and C. Rovere, London.
26,193. COMBINED VENTILATORS and SKYLIGHTS, C. W. Brown.—(*W. F. Warden, United States.*)
26,194. DYNAMO-ELECTRIC GENERATORS, L. Torda, London.
26,195. TOYS, F. Christen, London.
26,196. BUCKLES for TROUSERS SUSPENDERS, A. Kluge, London.

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26,197. SELF-INTENSIFIED LIGHTS, J. W. Bray, Bradford.
26,198. PURIFYING PETROLEUM OILS, E. W. Wynne, Seacombe, Cheshire.
26,199. CHAIRS for STEAM PIPE COVERS, W. Cowan, Monkwearmouth, Sunderland.
26,200. ASH-TRAYS, E. M. Haseler, H. W. Buncher, and R. C. Rodgers, Birmingham.
26,201. JOINTS for SAFETY-PINS, R. L. Antrobus, Birmingham.
26,202. FRAMES and FITTINGS of CYCLES, J. Edwards, Folkestone.
26,203. SIFTING CHAFF, J. H. Turner and G. A. Gray, Warminster.
26,204. COMPOSITE BELTS, S. A. Jackson, Salford, Lancs.
26,205. SIGHTS for FIRE-ARMS, P. R. J. Willis.—(*K. Tideman and B. Culver, United States.*)
26,206. GAS OVENS, E. Atkinson, Bradford.
26,207. MACHINERY for IRONING LINEN, F. Coultas and A. Pick, Bradford.
26,208. FIRE LIGHTS, W. J. Wood and J. Callon, St. Helens, Lancs.
26,209. STEAM GENERATORS, H. Cruse, Manchester.
26,210. CHECK TILLS, W. J. Moylan-Jones, Birmingham.
26,211. TABLES, G. H. Ward, Liverpool.
26,212. ADJUSTABLE SHELF BRACKETS, H. Ridge, Barnstaple, Devon.
26,213. FASTENINGS for LOCKETS, C. Chandler, Birmingham.
26,214. NON-SKIDDING ARRANGEMENT for MOTOR CARS, A. A. de M. Tavoira, Heaton Moor, near Stockport, Lancs.
26,215. GUIDING WHEELS for MOTOR CYCLES, W. J. Tooley, Great Yarmouth.
26,216. HOLDING CANDLES, D. Gilmore, Belfast.
26,217. CARRIER for USE on VELOCIPEDES, H. G. Turner, Manchester.
26,218. CENTRIFUGAL MACHINES, J. W. Macfarlane, Glasgow.
26,219. APPARATUS for MAKING SPADES, W. Walt, Edinburgh.
26,220. TROUGHS for ELECTRIC MAINS, J. Wilkinson, London.
26,221. OBJECT HOLDERS for DRAWING, G. H. Edwards, London.
26,222. EMERGENCY SLIPPER BRAKE for TRAMCARS, G. E. Cousins and F. B. Sykes, Rochdale.
26,223. KNIFE CLEANER, J. C. Ferguson, Douglas, Isle of Man.
26,224. RECORDS for MECHANICAL PIANO PLAYERS, E. T. Whitelow, Manchester.
26,225. ENVELOPE, B. Thomson, Glasgow.
26,226. MIXER KNIVES of BRICKMAKING MACHINES, W. Scott, London.
26,227. COOLING GAS ENGINE PISTONS, F. W. Taylor, and Wilkes, Limited, Birmingham.
26,228. SPINNING COTTON, T. Ashworth and B. Whiteley, Manchester.
26,229. TARGET for RIFLE PRACTICE, D. Ashton, Manchester.
26,230. CUTTING CARDBOARD DISCS, J. and A. Wilkinson, Manchester.
26,231. BRACES, C. Twigg, Birmingham.
26,232. WINDING MACHINES, S. W. Wardwell, London.
26,233. SELF-LUBRICATING PULLEYS, S. W. Wardwell, London.
26,234. WINDING MACHINES, S. W. Wardwell, London.
26,235. CONTROLLER for WINDING MACHINES, S. W. Wardwell, London.
26,236. POWER TRANSMISSION MECHANISM, S. W. Wardwell, London.
26,237. POULTRY HOUSES, F. A. Miller, London.
26,238. RATION PACKS, A. M. Davis, London.
26,239. HERMETIC CANS, H. Brockelbank, London.
26,240. PRODUCING OPTICAL ILLUSIONS, J. C. W. L'E. Burges, London.
26,241. CLUTCHES for MOTOR CARS, J. B. Bowen, Coventry.
26,242. BOTTOM BRACKET AXLES, C. S. Ebbels, London.
26,243. RESILIENT TIRES, A. E. Shiner, London.
26,244. EQUALISING CURRENT of GAS, S. Chandler, J. F. Ball, and J. Chandler, London.
26,245. OPERATING SELF-CLOSING DOORS, R. Clarke, London.
26,246. MANUFACTURE of ILLUMINATING GAS, P. Busse, London.
26,247. SENSITIVE PHOTOGRAPHIC PRINTING PAPERS, E. C. Morgan, Richmond, Surrey.
26,248. SHUTTLES of CARPET LOOMS, A. Stubbs, London.
26,249. OUTDOOR SEATS, H. H. Gunstone, Sheffield.
26,250. CONTROLLING CHANGE SPEED GEAR, J. Marshall, Sheffield.
26,251. WIND SHIELD for OUTSIDE of TRAMS, J. B. Johnston, Manchester.
26,252. MUSIC STOOLS, F. Bailey, London.
26,253. EXPOSING PORTION of CONTENTS of RESERVOIR, T. H. Head and S. H. Pryor, London.
26 254. FREE WHEEL CLUTCHES for CYCLES, J. O. Peters, London.
26,255. VACUUM PANS, A. Neumann and G. Stade, London.
26,256. HOOK and EYE FASTENER, F. W. Russell, London.
26,257. MAKING LASTS for BOOTS, H. W. Mobbs, London.
26,258. MACHINES for MAKING GLASS BOTTLES, C. Leistner, London.
26,259. SUSPENDING POCKET KNIVES, J. C Vickery, London.
26,260. ELECTRIC ARC LAMPS, J. B. Sipe, London.
26,261. MUSICAL INSTRUMENTS, F. Kuhmayer and A. Duffek, London.
26,262. MAGNETIC SEPARATING APPARATUS, C. Scholl, Liverpool.
26,263. OIL PAINTS, F. T. Samples, Liverpool.
26,264. BELL PUSHES, R. H. Gayner, jun., Liverpool.
26,265. IGNITION TUBE APPARATUS for INTERNAL COMBUSTION ENGINES, A. Stimpson, London.
26,266. COCK for PREPAYMENT GAS METERS, J. R. Dupoy, London.
26,267. DRY CLOSETS, T. C. Line and T. N. Castle, London.
26,268. NON-LEAKABLE RESERVOIR FOUNTAIN PEN, F., G., and H. Froud, London.
26,269. COILS for ELECTRO-MAGNETS, J. B. Sipe, London.
26,270. HOT AIR DRIERS, F. Richards, London.
26,271. WEIGHT RECORDING SCALES, G. Goetz, London.
26,272. CUFF LINKS, A. Hardiman, London.
26,273. BURNISHING EDGES of SOLES of BOOTS, W. Sternefeld, London.
26,274. STEAM GENERATORS, D. Roberts, London.
26,275. CHAIRS, J. and R. J. Foot, London.
26,276. CHAIRS, J. and R. J. Foot, London.
26,277. VENTILATORS for LEADED LIGHTS, H. Hope and Sons, Limited, and F. G. Sternberg, London.
26,278. CONCENTRATION of SULPHURIC ACID, J. Mackenzie, London.
26,279. POSTAL COVER for BOOKS, J. R. Haynel, London.
26,280. BORING APPARATUS, M. Schierhorn, London.
26,281. MOUTHPIECES of TOBACCO PIPES, E. Moore, London.
26,282. SWITCH INSTALLATIONS for TELEPHONE EXCHANGES, Siemens Bros. and Co., Limited.—(*Siemens and Halske Akt.-Ges., Germany.*)
26,283. ELECTRIC METERS, O. Imray.—(*Société pour l'Exploitation de Compteurs Electriques Rittener and Co., Switzerland.*)
26,284. SPANNERS, E. Kennard, London.
26,285. ROTARY-FIELD ELECTRICITY METERS, C. D. Abel.—(*Siemens and Halske Akt.-Ges., Germany.*)
26,286. TARRED PAVING, S. Constable and N. Hart, London.
26,287. WASHING MACHINE for FIBROUS MATERIALS, F. Bernhardt, London.
26,288. ELECTRICAL APPARATUS for TRAINING HEAVY GUNS, Vickers, Sons, and Maxim, Limited, A. D. Williamson, and C. L. Sumpter, London.
26,289. AUTOMATIC RECORDING CAR SCALE, G. Goetz, London.
26,290. CONTROL of ALTERNATING-CURRENT MOTORS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,291. VAPOUR ELECTRIC APPARATUS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,292. JOINTS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,293. DYNAMO-ELECTRIC GENERATORS, Allgemeine Elektricitäts-Ges., London.
26,294. ELECTRIC BRAKES, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,295. ELECTRIC CONTROL SYSTEMS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,296. SPREADING ARTIFICIAL MANURE, H. R. Griffin, London.
26,297. JOINING RAILS, H. Goldschmidt and F. Lange, London.
26,298. TRANSPORTING APPLIANCES, J. R. and J. Temperley, and W. Alexander, London.
26,299. METALLIC CHAINS, L. A. Génard, London.
26,300. FUEL BRIQUETTES, J. Noll and E. Trainer, London.
26,301. PNEUMATIC TIRES, E. Moor, London.
26,302. MOTOR, PROPELLER, and CO-ACTING PARTS, G. Trouche, London.
26,303. TURNING LATHES, A. D. y Rovira, London.
26,304. RECEPTACLES for HOLDING LIQUIDS, A. P. Crabb, London.
26,305. COOLERS for INTERNAL COMBUSTION ENGINES, J. Spyker, London.
26,306. CONVERSION of ROTORY MOTION into OSCILLATORY MOTION, H. H. Young, A. Bergtheil, H. W. Young, and E. Bergtheil, London.

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26,307. REVERSING MOTION for MOTOR BOATS, A. Halls, Great Yarmouth.
26,308. ADJUSTABLE SPANNER, A. Steadman, Wigan.
26,309. ROTARY ENGINES, W. I. Phifer, Birmingham.
26,310. LOCKING JOINT for PIPES, E. J. Gammage, Dudley.
26,311. AUTOMATIC AIR VALVE, J. Wellings, Birmingham.
26,312. HOOKS, A. W. Patching and J. S. Smithson, Manchester.
26,313. PNEUMATIC TIRES, O. G. Moseley and D. Moseley and Sons, Limited, Manchester.
26,314. CONTROLLING the SUPPLY of AIR to BOILER FURNACES, J. J. Meldrum, W. W. Manfield, and Meldrum Brothers, Limited, Manchester.
26,315. SLICING and SAWING MACHINE, G. Durrant, Manchester.
26,316. CONVEYANCE of WARP BEAMS, G. and J. H. Nutter, Burnley.
26,317. COUPLINGS for COLLIERY TRAMS, W. H. Charles, Blaenavon, Mon.
26,318. ANTI-VIBRATORY LAMP ATTACHMENT, W. P. Smith, Oldham, Lancs.
26,319. BOOT LINING and LOOP COVERS, D. A. Berry, Northampton.
26,320. TINS for BAKING BREAD, A. Thompson, Keighley, Yorks.
26,321. DISPLAYING JEWELLERY, A. J. Mason and E. Warrillow, Edgbaston.
26,322. DRIVING MECHANISM for SMALL-WARE LOOMS, G. Hattersley and Sons, Limited, and J. Chadwick, Keighley, Yorks.
26,323. PRESERVING COMESTIBLES, C. E. Bladen, Stoke-on-Trent.
26,324. HIGH-PRESSURE WATER VALVES, J. E. Weston and E. Higgs, Watford, Herts.
26,325. EXTINGUISHER for PARAFFIN LAMPS, H. E. Smith and J. R. Dawson, Swindon.
26,326. PLAYING MINIATURE GOLF, T. Whitaker, Cheadle Hulme, Cheshire.
26,327. ELECTRIC SWITCHES, T. H. Large, Glasgow.
26,328. HOLDERS for DISPLAYING GOODS, T. M. Tripp, H. and W. B. Jackson, Liverpool.
26,329. FILLING AERATED WATER BOTTLES, D. Cuff and G. Watts, Liverpool.
26,330. CULTIVATOR, HORSE HOE and RIDGING PLOUGH, A. Ballach, Edinburgh.
26,331. GUARD for ELECTRIC CARS, F. Darnton, Millfield, Sunderland.
26,332. STAND for PLANTS, A. Chandler, Birmingham.

26,333. FOLDING TABLES, E. and C. A. Jones, Gloucester.
26,334. LAMP HOLDERS, T. S. Jones, Halifax.
26,335. SOIL CLOSETS on BOARD SHIPS, A. M. Gordon, Glasgow.
26,336. SOLE and HEEL PADS for BOOTS, R. B. Black, London.
26,337. TREATING ANIMALS' SKINS, G. H. Fawcus and A. Marr, Manchester.
26,338. FIRE-HYDRANT STAND-PIPE, J. D. Thomson and L. W. Crosta, West Bridgford, Notts.
26,339. REVERSIBLE GARMENTS, W. G. Hewlett, Dorchester.
26,340. PNEUMATIC TIRES, R. Harrison, Yiewsley, Middlesex.
26,341. PREPARATION for APOPLEXY, G. Schilling, Caterham, Surrey.
26,342. FASTENERS for LADIES' CORSETS, D. A. D. Brown, Glasgow.
26,343 AUTOMATIC COUPLINGS, A. H. Williams, Lanark, N.B.
26,344. TURBINAL ENGINES, A. Malcolm and W. Millar, Glasgow.
26,345. BLACK COLOURING MATTERS CONTAINING SULPHUR, R. Holliday and Sons, Limited, J. Turner, and H. Dean, London.
26,346. AUTOMATIC PIPE CLEANER, G. J. Glover, London.
26,347. JOINTS of UMBRELLAS, W. A. Bindley, W. J. Gell, and J. F. Boham, London.
26,348. TOY, C. Edmunds, London.
26,349. INJECTORS, J. C. and R. D. Metcalfe, London.
26,350. MACHINE for BREAKING COAL, L. Vojacek, London.
26,351. CONDUITS, A. Koren, jun., London.
26,352. SUPPORT for CORNICES, J. W. Mackenzie.—(*E. Mattsson and P. Wesdelius, Sweden.*)
26,353. SEALING PNEUMATIC TIRES, A. J. Hands, Birmingham.
26,354. STEAM PUMPS, A. J. Boult.—(*The Snider-Hughes Company, United States.*)
26,355. BANDAGES, W. I. Hadden, London.
26,356. PNEUMATIC TOOLS, A. J. Boult.—(*International Tool Company, United States.*)
26,357. CHAIRS, A. J. Boult.—(*W. Aggers, New Zealand.*)
26,358. RAILWAY PERMANENT WAY, L. E. Schlüssel, London.
26,359. COOKING RANGES, J. E. Russell, London.
26,360. MULTIPLE AIR CHAMBER for PNEUMATIC TIRES, G. H. de Nittis and V. Loiret, London.
26,361. MAKING BENZINE, R. B. Ransford.—(*L. Cassella and Co., Germany.*)
26,362. PROJECTILES, H. W. Holland and T. Woodward, London.
26,363. DENTAL TRAYS, A. B. Verrier, London.
26,364. MUD-GUARDS for WHEELED VEHICLES, G. E. Andrews, London.
26,365. MOUTHPIECES of TELEPHONES, L. Huttenbach, London.
26,366. CLEANING CIGARETTE HOLDERS, W. H. Taylor, London.
26,367. WIRELESS TELEGRAPHY, W. P. Thompson.—(*Gesellschaft für Drahtlose Telegraphie, Germany.*)
26,368. APPARATUS for MEASURING FLOUR, A. J. and C. K. Johnston, Liverpool.
26,369. CALENDARS, J. R. Haggarty, Liverpool.
26,370. LUBRICATING DEVICE for TRUCKS, R. A. Booth, Liverpool.
26,371. APPARATUS for MICROPHOTOGRAPHY, J. A. Weale, Liverpool.
26,372. PHOTOGRAPHIC CAMERAS, F. Kalkner, London.
26,373. INCANDESCENT MANTLE SUPPORTS Falk, Stadelmann and Co., Limited, and S. Falk, London.
26,374. AUTOMATIC SWITCHES, H. Leitner, R. N. Lucas, and H. Hill, London.
26,375. FILING DEVICE, J. S. Reekie, London.
26,376. CASH REGISTERING TILLS, M. W. Smith, London.
26,377. WORKING ORDNANCE, A. T. Dawson and J. Horne, London.
26,378. OIL LAMPS, J. P. Pullin, London.
26,379. BILLIARD TABLE CLOTHS, V. B. Hubbell, London.
26,380 RAILWAY SLEEPERS, L. Voirin, London.
26,381. MECHANICAL STOKERS, J. Cowan, London.
26,382. INTERNAL COMBUSTION ENGINES, J. Thomas, London.
26,383. PURIFYING CRUDE VISCINE, W. Loebell, London.
26,384. MANUFACTURE of PLASTERS, W. Loebell, London.
26,385. TWO-CYCLE GAS ENGINE, F. von Handorff, London.

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26,386. MUFFS, R. de Witt, London.
26,387. SCREW-DRIVER, H. Harman, London.
26,388. WATER HEATERS and GEYSERS, J. W. Russell, London.
26,389. KITCHEN and FURNACE BOILERS, C. Buck, London.
26,390. CANDLE HOLDERS, R. H. and J. J. Hepburn, Birmingham.
26,391. UTILISING ELECTRO-MAGNETIC WAVES, M. H. Smith, London.
26,392. LOCKS, S. Wakelam, W. Chatham, and T. Wilkes, Birmingham.
26,393. TAOUSER PRESSES, J. M. Sims, Leeds.
26,394. MEASURING LIQUID, H. J. Emuss and J. Bird, Ipswich.
26,395. BEER ENGINES, C. Chambers, Birmingham.
26,396. TABLE FORK CLEANER, R. E. Green, London.
26,397. BLIND CORD FASTENER, F. Dyer, Newport, Mon.
26,398. TOOLS for DATING TICKETS, H. B. Srawley, Birmingham.
26,399. FENCE for MINING CAGES, H. Houghton, Skelmersdale, Lancs.
26,400. RESILIENT TIRED WHEELS, J. Partington, Keighley, Yorks.
26,401. LUBRICATORS, G. Fisher and V. Krosli, Manchester.
26,402. COVERS for PNEUMATIC TIRES, The Century Tanning Company, Limited, and S. D. Meredith-Jones, Manchester.
26,403. BASEMENT STRUCTURES, C. G. Robinson and J. Kershaw, Manchester.
26,404. TURNOVER MECHANISM for ROLLING MILLS, Steel, Peech and Tozer, Limited, and H. E. Bowen, Sheffield.
26,405. BOOT HEEL PROTECTORS, J. J. Allen, Blackpool.
26,406. SINKS, N. Dewhurst, R. T. Griffiths, and J. W. and S. Moore, Halifax.
26,407. BRUSH for CLOTHES and HATS, W. S. Hawker, Bristol.
26,408. WASHING BOTTLES, G. A and C. C. Farrar, Halifax.
26,409. BOARD for TRAWLING NETS, C. W. Brompton, Stockton-on-Tees.
26,410. TABLES for BEDSTEADS, R. P. Taunton, Birmingham.
26,411. AUTOMATIC GATE or DOOR LATCHES, P. S. Rae, Glasgow.
26,412. LUGGAGE CARRIERS for CYCLES, T. Clarke, Manchester.
26,413. VARIABLE SPEED GEARING, I. Cohen, Manchester.
26,414. FIRE-PROOF FLOORING, A. Hoffmann, London.
26,415. SPEED INDICATING APPARATUS, J. H Collie, Liverpool.
26,416. STOVES, D. Marshall, Cheltenham.
26,417. STOVES, D. Marshall, Cheltenham.
26,418. PROPELLING VESSELS, L. Wilson, Greenock, N.B.
26,419. REVOLVING CRANES, H. G. Cameron, Ilford.
26,420. NON-REFILLABLE BOTTLES, H. Ferno, London.
26,421. NON-SLIPPING HORSESHOE, W. Lowen, London.
26,422. EGG CUTTERS, M. S. F. Petersen, Hamburg, Germany.
26,423. THREADED BOX, M. S. F. Petersen, Hamburg, Germany.
26,424. CARPET BRUSH, M. S. F. Petersen, Hamburg, Germany.
26,425. SNOW PLOUGHS, C. Dietrich, Magdeburg, Germany.
26,426. CONSTRUCTION of WAINSCOTING, C. H. Biss, Birkenhead.
26,427. PNEUMATIC SADDLES and COLLARS, G. E. Hadley, London.
26,428. EDUCATIONAL APPLIANCES, J. F. Williams, Chingford, Essex.
26,429. COTTON CONDENSERS, C. A. Brown and A. St. Ouge, London.
26,430. CONSTRUCTING JOINTS of PULLEYS, G. Richards, London.
26,431. EXPLOSIVE VAPOUR ENGINES, P. Burt, Shettleston, N.B.
26,432. KETTLE, W. J. Deione, London.
26,433. GAS ENGINES, H. E. Soper, London.
26,434. CELLULOID MANUFACTURE, J. E. T. Woods and C. Morgan, London.
26,435. TROUSER-PRESSING APPARATUS, C. H. Doidge, London.
26,436. CARRIAGE DOOR WINDOWS, J. and E. J. Smith, London.
26,437. BRAKES for OMNIBUSES, J. W. Jennings, London.
26,438. SHARPENING RAZORS, R. O. Gräfe and S. Willet London.
26,439. INSERTING ELECTRIC LIGHT in FLOWERS for DECORATION, E. Bickersteth, London.
26,440. TIE FASTENER, R. E. G. Burroughs, London.
26,441. MEANS for CONSUMING SMOKE, T. R. Hays, London.
26,442. GAS PRODUCERS, J. A. Herrick, London.
26,443. BURNERS, R. H. Goodridge and A. W. Tait, London.
26,444. BOLTS, H. W. Martin, London.
26,445. MACHINE BRUSHES, V. I. Feeny.—(*C. Wirt, United States.*)
26,446. ELECTRICAL RHEOSTATS, V. I. Feeny.—(*C. Wirt, United States*)
26,447. MATCH-BOX and TOBACCO CUTTER, W. F. Dugins, London.
26,448. SELF-ADJUSTING PUMP PLUNGERS, J. Reid, London.
26,449. WIRE INSULATOR, S. B. Flynt and L. A. Maiden, London.
26,450. DINING and BILLIARD TABLE, W. Stevenson, London.
26,451. TELESCOPES, C. Soulas, London.
26,452. TOBACCO PIPES, W. F. Dugins, London.
26,453. LIME-SLACKING APPARATUS, G. P. and M. Wallis, London.
26,454. CLIPS EMPLOYED in TENTERING MACHINES, A. A. Whitley, G. Bentley, and J. Nuttall, London.
26,455. COLLAR STUDS, C. Mayer and E. G. Moore, Liverpool.
26,456. PIGMENT PROCESS, H. E. Newton.—(*Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
26,457. PRODUCTION of COLOUR LAKES, H. E. Newton.—(*Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
26,458. MERCURY VAPOUR LAMPS, O. D. Lucas, London.
26,459. SCREW JACKS, A. E. Lake, London.
26,460. ANTI-VIBRATION CYCLE DEVICE, W. J. Wyatt, London.
26,461. MEANS for BINDING LETTERS, J. Wilson, London.
26,462. CHOPPING MACHINES, M. Ruess, London.
26,463. CONSTRUCTION of ROOFS for BUILDINGS, H. Becker, London.
26,464. AIR PUMP, J. Hochgesand, London.
26,465. COVERINGS for STEAM PIPES, R. Illemann, London.
26,466. RAILWAY RAIL JOINTS, W. Watkins, Kingston-on-Thames.
26,467. BINS for USE in STORES, A. J. West, Kingston-on-Thames.
26,468. MACHINE for PULVERISING LAND, O. A. McFadden, Kingston-on-Thames.
26,469. FIRE EXTINGUISHERS, W. R. Pierce, Kingston-on-Thames.
26,470. SIGNAL APPARATUS for TRAMWAYS, R. J. J. Swan, London.
26,471. WATCH POCKETS, T. Delettran, London.
26,472. VACUUM BRAKES for RAILWAY VEHICLES, J. W. Cloud, London.
26,473. SPEED INDICATORS for MOTOR VEHICLES, L. Patz, London.
26,474. RAILWAY COUPLINGS, F. Podlaszecki, London.
26,475. ELECTRIC FIRE ALARMS, A. H. McNeil, London.
26,476. SIGHT for RIFLES, T. Mitchell and J. Hodgson, London.
26,477. MANUFACTURE of YELLOW SULPHURISED DYESTUFFS, C. D. Abel.—(*Akt.-Ges. für Anilin Fabrikation, Germany.*)
26,478. APPARATUS for the INTERCHANGE of HEAT, J. Heizmann, London.
26,479. THEATRES, A. and A. Kautzky and A. L. Maschl, London.
26,480. APPLIANCE for CALCULATING DISTANCES, R. H. Owen, London.
26,481. DEVICE for HANGING MEAT, E. R. Stone and G. W. Burtows, London.
26,482. BINDER for POSTCARDS, B. R. Hixson, London.
26,483. REVERSIBLE SEATS, A. K. Baylor, London.
26,484. SUSPENDED CABLE RAILWAYS, N. Loring, London.
26,485. COMBS for WEAVING LOOMS, M. Weill, London.
26,486. IMPROVED WINDOW FASTENINGS, W. T. Michell, London.
26,487. CENTRIFUGAL MACHINES, A. J. Boult.—(*The A. T. Hagen Company, United States.*)
26,488. AUTOMATICALLY CLOSING PUNCTURES, J. A. G. M. Durieu, London.
26,489. AXLE BOXES for RAILWAY WAGONS, J. P. O'Donnell.—(*T. G. Fergueson, Argentine.*)
26,490. CULINARY UTENSILS and LIDS, F. E. Hornidge, London.
26,491. STEAM GENERATORS, F. A. Fromont, London.
26,492. SWINGING or FOLDING BEDS, J. C. Bahr, London.
26,493. PRODUCING GAS, The Chalk Power Gas Syndicate, Limited, and R. Pearson, London.
26,494. VARIABLE SPEED GEARS, F. Mitchell and P. James, London.
26,495. SPINDLES, A. Anèce-Dartois, London.
26,496. BATH CABINETS, W. E. Monro, London.
26,497. FIRING DEVICE for ROTARY FURNACES, P. Larsen, London.
26,498. PETROL MOTORS, E. Canneval and J. Journaux, London.
26,499. "CHIT"-BOOK, T. Wright, Hongkong.
26,500. CURING CONSUMPTION, J. Pugh, New South Wales, Australia.

6th December, 1904.

26,501. ENCLOSING GAS LIGHT, J. W. Strutt, Ipswich.
26,502. VESSELS PROPELLED by STEAM, E. C. Robinson, Durham.
26,503 OPERATING ENGINES, W. J. Crossley and J. Atkinson, Manchester.
26,504. RESERVOIR PENHOLDER. F. C. Edgar, Bristol.
26,505. THREE-WAY COCK and LIQUID MEASURE, F. L. J. Limazin, Braintree, Essex.
26,506. RAISING DEVICE for PICKLING IRON PLATES, G. H. Bowden, F. Anderson, and C. A. Atchley, Manchester.
26,507. FIXING PAPER SEALS to BOTTLES, L. Johnson and J. H. Jefferies, Wolverhampton.
26,508. PRESERVING the SHAPE of BOOTS, W. Hülsmann, Stockton-on-Tees.
26,509. HEAD POLES for BEDSTEADS, S. I. Whitfield, Birmingham.
26,510. "EXTRACTOR" COUPLING, A. Pidgeon, London.
26,511. WINDOWS, A. and D. Black, Glasgow.
26,512. BUOYANT LIFE-SAVING APPARATUS, G. L. Burnett, Glasgow.
26,513. STEEL POLISH, T. Mullany, Dublin.
26,514. VALVE CHEST, C. A. Beck, Barton-on-Humber, Lincs.
26,515. FIRE ALARM SIGNALS, J. and G. J. Sutton, London.
26,516. ARTIFICIAL STONE COMPOSITIONS, J. Staudt, London.
26,517. SPRING BALANCE SCALES, A. N. Ozias, London.
26,518. AIR PUMPS, P. Thomas and J. S. Marsland, Halifax.
26,519. STEAM SAFETY VALVES, H. W. and W. H. Richards, Manchester.
26,520. ACETYLENE LAMP, J. G. Ledwich and J. W. Lane, Blackrock, Co. Dublin.
26,521. BEAMING CLOTHS, T. H. K. and W. H. A. Lees, Halifax.
26,522. TRANSPORT, SHIELD, and AMBULANCE CART, J. Gorst, Chester.
26,523. FURNACE DOORS, W. Newlands, Edinburgh.
26,524. FRICTION CLUTCH, J. Berryman, Bristol.
26,525. REGULATING TEMPERATURE in STEAM GENERATORS, R. P. Roy, London.
26,526. HAIR PINS, A. W. Leigh, London.
26,527. ELECTRIC IGNITION APPARATUS, A. Eckstein and H. J. Coates, Manchester.
26,528. APRONS for USE on ROAD VEHICLES, C. E. Green, Glasgow.
26,529. ELECTRIC STORAGE BATTERIES, R. J. Crowley and A. Blackman, Hampton Wick, Middlesex.
26,530. BRAKE MECHANISM for BICYCLES, L. A. Hermann, Hamburg, Germany.
26,531. TOY, J. Hille, Hamburg, Germany.
26,532. FIGURING GLAZED PAPER, G. Hennessen and P. Spix, Cologne, Germany.
26,533. MACHINE for STRETCHING LEATHER, C. C. W. Eddels, London.
26,534. MEANS for SCORING at BILLIARDS, A. E. Bates and W. Wand, London.
26,535. FORMING a CORNER in SHEET METAL, S. Smith, Merton.
26,536. INTERNAL COMBUSTION ENGINES, A. H. Miller, London.
26,537. IMPARTING MOTION to ADVERTISEMENTS, P. W. Doell, Brighton.
26,538. ELECTRICAL FUSE BOXES, F. Herbert, London.
26,539. MILLING CUTTERS, T. Eynon, London.
26,540. APPARATUS for WARMING FOOD, W. A. S. Benson, London.
26,541. DAVITS, J. T. Lihou and F. W. Irvine, London.
26,542. STEREOTYPE MACHINES, H. E. Newton.—(*R. Hoe, United States.*)
26,543. ANTI-VIBRATION DEVICE for CYCLES, W. Toms, London.
26,544. PHONOGRAPH TRUMPETS, C. Molt and C. Bozler, London.
26,545. MOULDED STONE for WINDOW SILLS, E. Stenzel, London.
26,546. CUSHIONS for HERNIA TRUSSES, W. Wagner, London.
26,547. TOILET SET, A. E. Moore and A. Darch, London.
26,548. TREATING CABOOSES in SHIPS, L. Williams, London.
26,549. SHEARING BLOCKS, G. M. and C. H. Solby, London.
26,550. COOKING STOVES, M. L. Krimer, H. Cutajar, and P. and E. W. Bayley, London.
26,551. CLEANING VEGETABLE FIBRES, P Acatos, London.
26,552. ELECTRICITY or GAS LANTERNS, S. Biheller, London.
26,553. FURNACE DRAUGHT REGULATOR, J. Milton, London.
26,554. MASHING PROCESSES, C. H. Caspar and J. P. Fitzgerald, London.
26,555. CUTTING FABRICS, H. H. Lake.—(*Crompton Company, United States.*)
26,556. REGULATING TEMPERATURES, E. H. Hunter, London.
26,557. PRODUCING METALS by ELECTROLYSIS, A. J. Boult.—(*E. A. Ashcroft, Algeria.*)
26,558. HORSESHOES, H. Bartley, London.
26,559. HORSESHOES, A. J. Boult.—(*H. Bartley, United States.*)
26,560. COMPOSITE BOARDS for BLINDS, S. Frank, London.
26,561. LEGGINGS, G. Clarke, London.
26,562. AGRICULTURAL IMPLEMENTS, J. E. Holyoak, London.
26,563. COMPOSITION for WASHING, N. Thestrup, London.
26,564 LINERS for BUNG HOLES of CASKS, A. Nixon, London.
26,565. WIRE-CUTTING APPLIANCES, E. A. Jeffreys, London.
26,566. MECHANISM for OPERATING WINDOW SASHES, G. J. Whitfield, Birmingham.
26,567. CHIMNEY POT, W. Barrett, London.
26,568. MEANS of ATTACHING PNEUMATIC TIRES, E. P. Prestwich, Coventry.
26,569. PREVENTING SIDESLIPS of ROAD VEHICLES, E. P. Prestwich, Coventry.
26,570. LEMON SQUEEZER and STRAINER, D. Guppy and M. Herbert, London.
26,571. APPARATUS for FASTENING the ENDS of DRIVING BELTS, H. Simmons, London.
26,572. PRINTERS' PLATE BLOCK, A. E. Edwards.—(*W. Dove and W. A. La Sor, United States.*)
26,573. COLOUR PHOTOGRAPHY, E. R. Clarke, London.
26,574. VOICE REPRODUCING APPARATUS, A. Molokoff, London.
26,575. VELOCIPEDES, H. H. Lake.—(*N. J. Greenison, United States.*)
26,576. DIVING APPARATUS, H. H. Lake.—(*G. Pino, Italy.*)
26,577. FORK CLEANER, A. S. Lowe, London.
26,578. APPARATUS for COOLING LIQUIDS, A. S. Barham, London.
26,579. MUSICAL INSTRUMENTS, F. Kühmayer and A. Duffek, London.
26,580. CLAY CLEANING MACHINES, H. Diesener, London.
26,581. BOTTLE FILLING APPARATUS, N. Thestrup, London.
26,582. DIRECT-CURRENT DYNAMO ELECTRIC MACHINES, C. E. Davies, London.
26,583. STEAM LUBRICATING APPARATUS, W. Michalk, Liverpool.
26,584. SPACING EQUALISING APPARATUS, C. E. Bailey, Liverpool.
26,585. SHAVING CUPS, W. E. Cooper, Liverpool.
26,586. TRANSMISSION of OPTICAL IMAGES, C. J. E. and F. X. E. M. Belin, Liverpool.
26,587. REVERSIBLE WINDOW SASHES, F. de J. Clere, Liverpool.
26,588. SYSTEMS of ELECTRICAL DISTRIBUTION, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,589. ELECTRIC SWITCHES, The British Thomson-Houston Company, Limited.—(*The General Electric Company United States.*)
26,590. FILING MACHINES, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States*)
26,591. ELASTIC FLUID TURBINES, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
26,592. GOVERNORS for STEAM ENGINES, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
26,593. ELASTIC FLUID TURBINES, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
26,594. ELASTIC FLUID TURBINES, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
26,595. LUBRICATING TURBINES, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
26,596. TURBINES, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
26,597. TURBINES, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
26,598. SHAFT PACKINGS, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
26,599. TURBINES, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
26,600. WIL'M-GIN, N. Garcsinski, London.
26,601. LOCKING BICYCLE when not USED, G. H. Fry, London.
26,602. PRODUCTION of REACTIONS in GASES, J. Y. Johnson.—(*Badische Anilin and Soda Fabrik, Germany.*)
26,603. HOLDING OVERHEAD WIRES, I. E. Winslow, London.
26,604. FIRE-EXTINGUISHING APPARATUS, J. W. Rostler, London.
26,605. BRAKE and CLUTCH MECHANISM, C. A. Arbey London.
26,606. FLUSHING NOZZLE, J. G. Lorrain.—(*The St. Louis Street Flushing Machine Company, United States.*)
26,607. BRAKING MECHANISM for VEHICLES, T. L. Mitchelmore and E. M. Bowden's Patents Syndicate, Limited, London.
26,608. NON-REFILLABLE BOTTLES, L. Lambert, London.
26,609. CLOSING BAGS, H. I. Barts and S. W. Neumann, London.
26,610. UTILISING SCORIAE DERIVED from the REDUCTION of ANTIMONY, C. Savigny and M. Douxami, London.
26,611. FOOTWEAR, H. Stein, London.

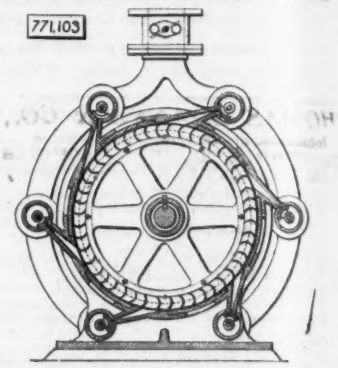
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

771,103. STEAM TURBINE, *S. N. Smith, Philadelphia, Pa.—Filed March 30th, 1904.*

Claim.—In a steam turbine, the combination of a moving member having a series of arms forming spiders, rims connecting said arms, annular rings carried by said rims, a series of ranges of buckets or

771,103



blades carried by said annular rings, the latter having grooves formed directly in their faces to secure and position said buckets or blades in place, and nozzles arranged to direct steam across the face of said buckets or blades.

771,271. CENTRIFUGAL PUMP, *T. Reuter, Winterthur, Switzerland.—Filed February 1st, 1902.*

Claim.—(1) In a centrifugal pump, a casing having an intake chamber and a delivery chamber, runners arranged within said casing between said chambers, and an outlet valve communicating with the intake chamber and operating to permit the escape of collected or accumulated air therefrom, as and for the purpose set forth. (2) In a centrifugal pump, a casing having an inlet and an outlet chamber and runner interposed between said chambers, in combination

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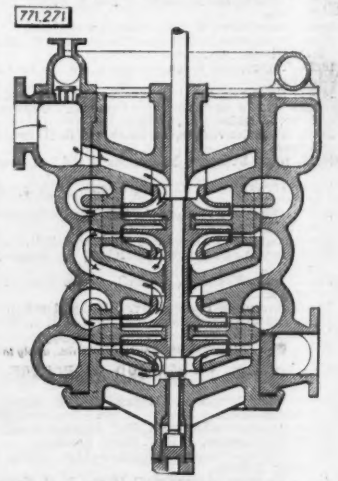
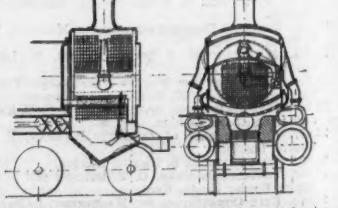


with an auxiliary chamber communicating with said intake chamber, and valves for controlling said communication, as and for the purpose set forth. (3) In a vertical centrifugal pump, a casing, an inlet and an outlet chamber, runners arranged within said casing, said inlet chamber being located above said runners, and said outlet chamber arranged below said runners, and a valve-controlled passage communicating with said inlet chamber to permit any air collected in said chamber to be withdrawn therefrom, as and for the purpose set forth.

771,630. SUPERHEATER, *C. Hagans, Erfurt, Germany.—Filed March 24th, 1904.*

Claim.—(1) The combination with the smoke-box of a locomotive, of a superheater arranged therein, and means independent of the fire-box of the locomotive for heating said superheater. (2) The combination

771,630



with the smoke-box of a locomotive, of a superheater arranged therein, and a furnace independent of the fire-box of the locomotive for heating said superheater. (3) The combination with the smoke-box of a locomotive, of a superheater arranged therein, and a furnace arranged exteriorly of the smoke-box and independent of the fire-box of the locomotive for heating the superheater.

RECENT LOCOMOTIVE WORK ON THE LONDON AND NORTH-WESTERN RAILWAY.

By CHARLES ROUS-MARTEN.

No. IV.*—*Concluding Article.*

BEFORE closing my notes on the recent locomotive work of the London and North-Western Railway, I ought to say a few words about the performances of some of the older engine types which still take a large share of the important duties. These are chiefly (1) the unaltered "Alfred" four-cylinder compounds, Nos. 1941-1980; (2) the "Jubilee" compounds, Nos. 1901-1940; (3) locomotives of the old non-compound coupled class, some 6ft. 6in., some 6ft. coupled, the two classes numbering 256 in all, and dating back to 1863; (4) the still older 7ft. 6in. single-wheelers, of which more than 50 remain, and which date back to 1862, and even 1859.

Taking first the unaltered compounds of Mr. Webb's latest—or "Alfred the Great"—class, my personal experiences with them seem to indicate that while they can maintain a respectably high average speed with light or moderate loads, they have little or no reserve of speed to be called on in case of lost time or a late start having to be made up. They have appeared to me sluggish—in fact, resembling in this respect the original three-cylinder compound class, such as "Experiment," &c., and the latest of that type, the "John Hick" class, but differing from the "Teutonic" set—ten in number—which possessed notable speed capacity, a quality sometimes displayed also, if in less degree, by the older "Dreadnoughts" and by some engines of the eight-wheeled—or "2-2-2-2" class—the "Greater Britains." Thus I gave in the columns of THE ENGINEER full particulars of the record run from Birmingham to Euston made by No. 1960, Francis Stevenson, of the "Alfred" class. It may be remembered that the run of 113 miles was performed in 114 min. 56 sec., representing an average rate of exactly 59 miles an hour from start to stop. But the load was only 130 tons behind the tender, so it was feasible to maintain this high average by keeping a high uphill minimum which rendered any great velocity downhill needless.

I made two experimental trips with compounds of the "Alfred the Great" class on the 3½-hour expresses from Manchester to London—that which starts from Manchester at 4.10 p.m., and runs from Stockport to Euston, 183 miles, without a halt. In both cases the loads were the same, viz., ten coaches, or approximately 200 tons—including passengers, luggage, staff, and stores, behind the tender. In one of these cases the engine was No. 1974, Howe, and time was kept to the absolute second from Manchester to London, while there was a gain of 2 min. 12 sec. from Stockport, the run of 183 miles thence to Euston being made in 3 h. 18 min. 48 sec., notwithstanding a long re-laying slack near Sandbach. The speed dropped to 45 miles an hour up the Madeley bank—three miles at 1 in 177—but kept to a minimum of 52·8 up the 1 in 330 to Tring. The fastest downhill was 69·2. In the other case, the locomotive was No. 1973, Hood, and the inclusive time from Manchester to Euston was only 3 h. 27 min. 35 sec., that from Stockport being 3 h. 15 min. 4 sec., or nearly 6 min. under booked time. The speed did not fall below 50 miles an hour up the Madeley rise, and the time for the 15 miles from Bletchley to Tring—passing in each case—was 16 min. 29 sec., as compared with 16 min. 31 sec. in the previous case—very close work, the minimum speed, too, being the same in both instances. Down the Roade and Tring banks a speed of 70·3 miles an hour was reached. The running times to Euston from Stafford and Rugby respectively were 140 min. 29 sec., and 86 min. 27 sec., the distances being 133½ and 82¼ miles. Each trip was entirely satisfactory, precise punctuality being observed in the one case and 2½ min. being gained in the other. Still, it must not be forgotten that one of the old and small non-compound coupled engines would—judging from their past performances, as in the case of Charles Dickens and others—have done the journey in equally good time with the same load. Two other runs with the unaltered "Alfreds" on the 4.30 p.m. down Birmingham express may be worth mentioning. In one case the train was run in duplicate, and the first portion of twelve coaches, or about 200 tons, was taken by No. 1975, Jupiter, without stopping at Willesden. The run of 65¾ miles to Northampton was done in 72¼ minutes net, the lowest speed just before Tring summit being 54·2 miles an hour, and the fastest, near Leighton, 70·3. In the other case the load was nineteen coaches, or 350 tons, and the engine No. 1977, Mars, piloted, however, by a 7ft. 6in. single-wheeler. The train was in good time, and ran easily to Northampton from Willesden in 64 min. 51 sec. for the 60¼ miles, without going slower than 54·2 miles an hour up to Tring or exceeding 68 downhill. This was very good going, but the "double-heading" was regrettable. With the altered valve gear Mars could certainly have kept time readily even hauling that heavy train.

All of these were fairly creditable performances so far as they went; but it was a noticeable feature, in the case of a second run by Francis Stevenson with the two-hours train from Birmingham to Euston, that she seemed quite unable to make up for a late start by any acceleration on the favourable portions of the road, differing strongly in this respect from the older non-compound engines, both single and coupled, which always showed themselves able, with similarly light loads, to pick up on such lengths as Roade—Bletchley and Tring—Willesden a considerable amount of lost time or lateness in starting. Some curious instances of this former characteristic came under my notice. No. 1946, Diadem, one of this class, was on the Irish express, timed to leave Euston at 11 a.m., which is booked to run to the first stop, Stafford—133½ miles—in 152 minutes, averaging 52·7 miles an hour. The load was reckoned as "fourteen coaches," namely, two twelves, six eights and one six, estimated to weigh approximately 260 tons—of which one eight-wheeler was slipped at Nuneaton, 97 miles from London, this leaving the load "12½ coaches," or about 235 tons, for the rest of the distance, behind the tender. Now, this should have been, one would think, an ideal load for an engine of that nominal power, and the timing was certainly mild, especially in view of the fact that the "Precursors" are now required to run the same distance with heavier loads in ten minutes less time, which they do with relative ease. The engine, Diadem, however, proved unable to accomplish this comparatively light task, and lost 2 min. 40 sec. between Euston and Stafford, taking 154 min. 40 sec. instead of 152 minutes. Examination of the intermediate passing times makes it quite clear that this unpunctuality was due to sluggishness. With that relatively moderate load we took 5 min. 56 sec. to cover the first 1¼ miles, 43 min. 11 sec. to the Tring Summit—31¾ miles—58 min. 4 sec. to Bletchley, no higher speed than 67 miles an hour being reached down the tempting descent after Tring, 72 min. 8 sec. to Roade—59¾ miles—96 min. 38 sec. to Rugby—passing—2 h. 7 min. 20 sec. to pass Tamworth—110 miles. Again, No. 1956, Illustrious, of the same class, with a train reckoned as "15½ coaches," booked to run from Stafford to Crewe, 24½ miles, in 31 minutes—no headlong timing—occupied 33 min. 12 sec. in the actual running, thus losing more than two minutes in that short distance. It is true that one slight check was encountered at the Whitmore Summit; this, however, should easily have been made up, but there was no indication of any such result. So the time was lost. The highest speed down the Madeley bank was 66·6 miles an hour. In another case No. 1965, Charles Mason, on the same train, with an identical load, made the same journey in 29 min. 14 sec., thus gaining 1¾ minutes. In this instance, however, the downhill speed was as high as 73·8 miles an hour. The comparison shows the curious difference that was to be found in the work of these compounds as originally built. When the more relatively feeble performances are compared with that of Alfred the Great since the alteration of her valve gear by Mr. Whale—see THE ENGINEER, December 9th, p. 559—it will at once be perceptible what a remarkable difference has thus been made in the capacity of the engines.

Similarly variable and often disappointing, although also sometimes good, were the performances of the earlier four-cylinder compounds, of the "Jubilee" class. So long as they were not called upon to maintain a higher average than 50 to 52 miles an hour on the main line, they were able to keep time with heavy loads, as in the case of the oft-quoted run with the members of the Institution of Civil Engineers, when No. 1903, Iron Duke, hauling 339 tons, averaged exactly 50 miles an hour from Euston to Crewe, and 52·4 miles an hour from Crewe to Euston. Or as in another case, more than once quoted by myself, when No. 1912, Colossus, of this type, ran from Euston to Crewe in the booked time of 190 minutes for the 158 miles, averaging 49·8 miles an hour, with a load reckoned as "22 coaches," and estimated at 360 tons behind the tender, as computation then went. But, on the other hand, that same engine, No. 1912, Colossus, with a load reckoned only as "14½ coaches," or 280 tons, occupied 47 min. 33 sec. on the easy run from Crewe to Liverpool, thus losing more than 2½ minutes on the very moderate booked time, instead of making up anything, as ought to have been done without difficulty, of the five minutes' late start out of Crewe. All of this was disappointing work, and so was that of No. 1923, Agamemnon, which ran the 9·20 a.m. Euston—Birmingham fast train on its opening day, and lost eight minutes to Coventry. As against these cases of poor doing I am able to set others of more creditable running. Perhaps my best recent experience with this type occurred one day when the 10 a.m. down Scotch express was running in duplicate; the first portion, reckoned as "13½ coaches," or 270 tons behind the tender, was taken by No. 1906, Robin Hood. Starting from Euston 2½ minutes late and from Willesden nearly five minutes late, Robin Hood made the run of 77 miles thence to Rugby in 85 min. 5 sec., averaging 54·3 miles an hour; from Rugby to Crewe, 75½ miles, in 80 min. 49 sec., averaging 56·1 miles an hour, the lowest rate up the Tring bank being 51·1 miles an hour, and the fastest down the Madeley bank 70·3. This was certainly respectable. Also No. 1907, Black Watch, hauling "13 coaches," or 245 tons, ran from Northampton to Euston, start to stop, in 73 min. 41 sec. for the 65¾ miles, averaging 53·6 miles an hour. I may note, further, the exceptional smartness of the previous run in to the stop at Northampton from passing Buckby, 10 miles, in 8 min. 48 sec., the final 6½ miles to the Northampton stop being done in 5 min. 29 sec., and a speed of 74 miles an hour being attained down the long stretch of 1 in 200. All these experiences go to show that the London and North-Western four-cylinder compounds, in their original shape, were capable of fair work and sometimes did it, but were variable, and hence untrustworthy, often sluggish, and not to be depended upon when heavy loads were associated with modern high speeds. There being no fewer than 80 of these engines, beside the 100 three-cylinder compounds, it is gratifying to know that the comparatively simple change made by the new chief mechanical engineer has proved sufficient to convert, at any rate, the four-cylinder compounds into really useful and powerful locomotives, notwithstanding that the "Jubilees" have only 1379 square feet, and the "Alfreds" only 1557 square feet of heating surface, instead of at least 50 per cent. more, as is ordinarily given to engines of that nominal power.

Regarding the older non-compound engines, both single and coupled, I have little fresh of interest to record, as in most recent cases when I travelled with them they were either running in pairs on heavy trains or else piloting compounds. Two very smart performances, however, deserve mention. In one case, the re-built 6ft. coupled express engine, No. 424, Sirius, with a train of "12 coaches," or 180 tons, ran from Oxenholme to Carnforth, 12¾ miles, start to stop, in 12 min. 50 sec., the smartest run I have ever had between those stations, and attained a maximum rate of 80·3 miles an hour. The gradient, however, falls almost the whole way. The other case was that of a 7ft. 6in. single-wheeler, No. 667, Marmion, built in 1862, which, hauling a train of "13 coaches," or some 230 tons, made the run from Rugby to Willesden in 88 minutes, start to stop, a most remarkable achievement for so old and nominally feeble a locomotive. In many instances six-coupled goods engines, with 5ft. wheels, were used on express trains, a proceeding of doubtful wisdom, one would imagine, and possibly unsanctioned by the authorities. These goods engines sometimes kept time, sometimes they did not. One ran an express of 10 coaches, or 170 tons, from Bletchley to Willesden, start to stop, in 48 min. 44 sec. for the 41¼ miles, with a signal slack at Watford, and another approaching Willesden, which cost us quite 2 minutes. We took 20 min. 42 sec. from the start to pass Tring, distance 15 miles, but in descending the subsequent bank, attained a rate of 67 miles an hour. Such a proceeding, however, can hardly be taken seriously.

Reviewing as a whole my recent experiences on the London and North-Western, I think it may fairly be said that they show not only much excellent locomotive work, and some almost phenomenal, but also exhibit an improvement and a tendency toward still further advance which are even more gratifying, and which do credit to the company and its officers.

Perhaps I may be permitted—as having made, during the past twenty years, probably as numerous and extensive independent observations of the working of the London and North-Western engines as any man living—to say in conclusion a few words to make clear the true position as regards the compound express locomotives of that railway. These have numbered 180 in all, and may be separated into two main divisions, the three-cylinder type and the four-cylinder type, the former numbering 100 and the latter 80. In their original shape they failed to the extent that they proved unable to accomplish the particular work for which they were designed and built, viz., to haul the heaviest modern London and North-Western loads at the fastest modern London and North-Western speeds, although they did a great deal of very respectable second-class duty. There never has been any secret as to the chief reasons why neither type proved wholly satisfactory. In the case of the three-cylinder engines the principal fault was that the driving wheels were not coupled, whence arose frequent failures of synchronism between the high-pressure and low-pressure machinery, causing loss of efficiency. In the case of the four-cylinder engines the main error consisted in not providing a separate cut-off for the high-pressure and low-pressure cylinders. In this latter case Mr. Whale has recognised the fault, and has remedied it, with the excellent results set forth in my previous article. In the case of the three-cylinder engines the mistake appears to be deemed irremediable, and so the engines of that type, although not so old by one-half as many of the London and North-Western non-compound engines, are being broken up. But within the small compass indicated lies, as in a nutshell, the true solution of the riddle: Why have not either the three-cylinder or the four-cylinder London and North-Western compounds been more successful? The Great Western compound engine La France has answered the question in both its branches, and I do not doubt that the others now under order—which, by-the-bye, follow the dimensions of the later French "Atlantic" compounds, built for the Paris-Orleans Railway, as did "La France," the earliest which were built for the Chemin de Fer du Nord—will by their work emphasise the same point.

* No. III. appeared December 9th.

DESIGN OF HIGH-SPEED ENCLOSED STEAM ENGINES.

No. V.*

THE piston and valve, illustrated in Figs. 31 and 32 below, illustrate a successful type of ring as made by Messrs. Dobson and Co., of Belfast. These should have been included in our issue of November 4th. Referring to Fig. 31 it will be seen that a wave spring is fitted on the steam side of the rings, and this spring acts in conjunction with the steam and prevents the ring rising from the steam-tight face of the piston. This ensures a tight piston and freedom from clattering rings. Each ring is prevented from expanding beyond the required diameter

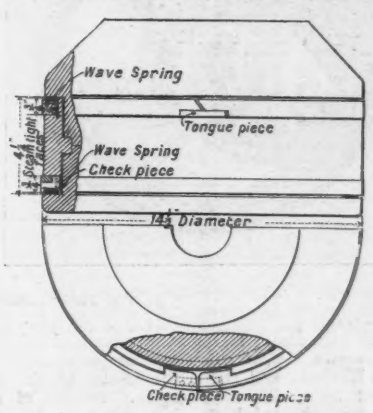


FIG. 31—DOBSON PISTON RING

by checks, as shown in the plan. This reduces friction to a minimum, and saves the excessive wear so often experienced with rings expanded by independent springs. Rings of this class have been working in high-speed engines for a considerable length of time with general satisfaction. The piston valve illustrated in Fig. 32 is made on similar lines to the piston just described, and needs no description. A tongue piece is

* No. IV. appeared December 9th.

fitted at the joint of the rings for both piston and piston valve.

MESSRS. J. AND H. MCLAREN, of Midland Engine Works, Leeds, have not followed in the paths of the majority of high-speed engine builders. Having been manufacturers of engines for nearly thirty years, they have had very considerable experience in this branch of mechanical engineering. They have been strong advocates for the triple-expansion engine of the three-cylinder type since they commenced building engines for electrical work, and were about the first to introduce this type of engine into electric generating stations. This they did with most satisfactory

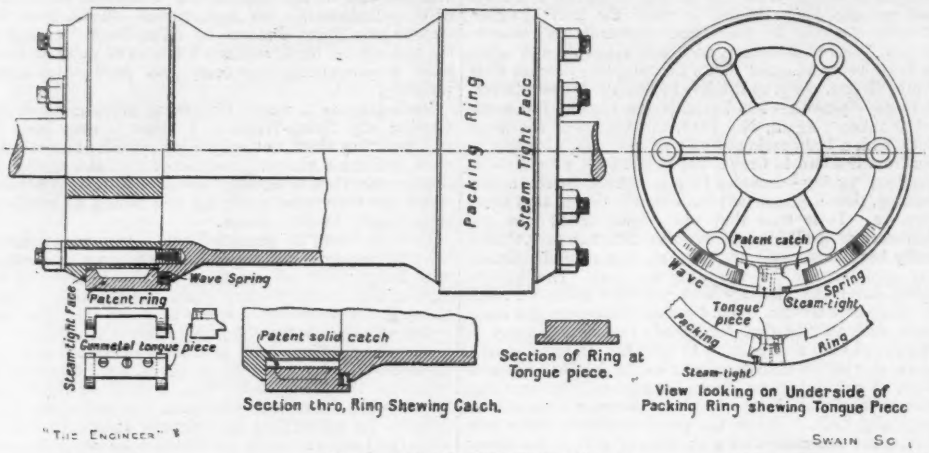


Fig. 32—DOBSON PISTON VALVE

results, and being convinced that the three-cylinder triple-expansion engine was the best type, given a reasonable pressure of steam to work with, they faithfully kept to their ideas, and built a large number of medium and slow speed engines of this class. Now they have the satisfaction of seeing that their ideas have become general, and triple-expansion engines being installed everywhere. Of recent years they have taken up the manufacture of high-speed, enclosed, forced lubrication engines of the triple-expansion type. Unlike nearly all the other manufacturers of this class of engine, they adopted the use of flat slide valves of the balanced type for the distribution of steam

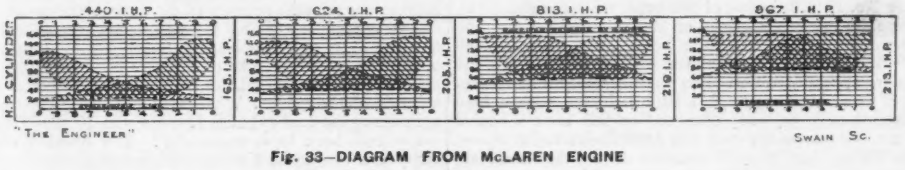
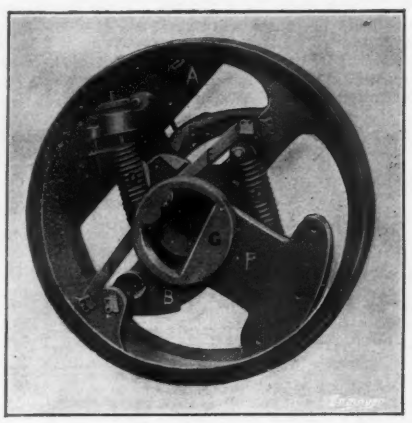


Fig. 33—DIAGRAM FROM McLAREN ENGINE

to all cylinders. These they claim to be more economical than piston valves, and to remain tight for years. There is no doubt that it is possible to reduce the clearance volume in the cylinders to a minimum by the use of flat slides, and that tight valves can be maintained, both items of which are great points in favour of an economical engine, and, judging from the results they obtain, these are borne out in practice. For instance, a triple-expansion engine with cylinders 19½in., 30in., and 48in. diameter, and a stroke of 24in., running at 125 revolutions per minute, had a consumption of 12·52 lb. per indicated horse-power per hour when



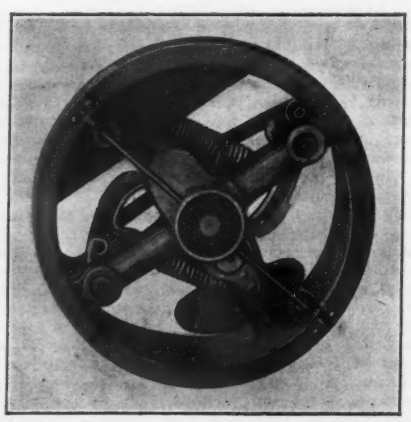


Fig. 33—McLAREN CRANK SHAFT GOVERNOR

supplied with steam at 166 lb. pressure, and exhausting into a vacuum of 27in. This test was conducted by Mr. Wilson Hartnell, and shows the results which can be obtained by a slide-valve engine. Results of under 12 lb. per indicated horse-power per hour have been obtained with some engines using only saturated steam. Another feature which Messrs. McLaren have made a great success on their engines, after many years of costly experimenting, is their variable expansion governor. They hold that it is a well-recognised fact that it is more economical to govern by variable expansion down to a certain point, after which it is more advantageous to throttle the steam. The governor used by this firm appears to bring about this result, as will be seen from the diagrams illustrated in Fig. 33. Variable expansion becomes an easy matter to effect when a trip gear is used, as for Corliss engines. In that case the governor has very little to do, and is very little affected by the valve gear. In the case of high-speed and medium speed engines, however, trip gears are out of the question, and cannot be used, and the governor has to act directly upon the excentric of the distributing valve, and drive the valve gear, unless some very special gear is introduced. This means that the governor has to be very powerful, and must not be affected by the valve gear itself. The McLaren crank shaft governor illustrated in Fig. 34 combines the properties of centrifugal force and inertia. The power of the governor is produced by centrifugal force acting on two weights, which are each coupled to an inertia weight.

The centrifugal weights B B, which swing on pins C C, are shown at rest on the boss of the governor wheel A, being held against it by the spiral springs D D. As the speed of the engine increases, the centrifugal force acting on the weights B B causes them to move outwards towards the rim of the wheel. The rods E E connect each weight to a steel casting F, which is mounted and can turn on the stalk G. One end of this casting forms the excentric for working the valve and the other end is a balance weight, care being taken that the one portion balances the other before it is put in the governor. It will thus be seen that every movement of the governor weights acts directly on the high-pressure valve of the engine. When the weights against the boss the excentric has its greatest throw, and when they touch the rim it has its least, which gives the valve a travel equal to twice the lap, but does not admit steam to the cylinder. The inertia weight F steadies the governor and prevents "pumping" of the weights, which is likely to occur when an unbalanced valve has to be driven.

The speed of the engine may be changed when it is running by means of a patented speeding gear which is attached to the governor. It consists of a pair of friction wheels which are controlled by a lever worked by hand. These are connected by gearing to each of the springs, and tighten or slacken them, according to which friction wheel is "held." By this means the speed of the engine can be varied up or down about 7½ per cent., or a total of 15 per cent., and this can be done without in any way affecting the action of the governor.

The table in the next column shows the result of a test of one of these governors.

A fine example of the engines turned out by this firm is illustrated on the next page; it is that at the Leeds Corporation Electricity Works.

These engines are their standard high-speed type of triple-expansion engine. They drive alternating current generators made by the Electric Construction Company, Wolverhampton, with a normal output of 1400 kilowatts, and an overload of 1540 kilowatts at a speed of 200 revolutions per minute with a steam pressure of 170 lb. of steam in the high-pressure steam chest, superheated to 100 deg. Fah. as a maximum, and are capable of developing the full load when exhausting into the atmosphere. They are double-acting, all the pistons are conical in form, the high-pressure and medium-pressure being of cast iron, and the low-pressure of cast steel. The valves are of the flat double-ported balanced pattern, the high-pressure one being controlled directly by a powerful crank shaft governor of the type just described, whilst the others driven by excentrics connected to the crank shaft couplings. There are two valves on the low-pressure cylinder, so that the travel of each is reduced to conform with the speed of the engine. The crank shaft is in three sections; each crank pin is balanced by a balance weight connected to each web.

The system of forced lubrication is very complete; there are two pumps, driven by excentrics on the crank shaft. They draw the oil from a reservoir underneath the engine bed-plate, and force it into two receiver pipes, from which smaller pipes run in every direction to the bearings and parts requiring lubrication.

Each pump has a complete system of its own, being entirely independent of the other. Every bearing has two pipes leading to it, one from each pump, so that if from any cause one pump is out of action, the other one supplies the engine with oil, being large enough for the purpose.

All the moving parts have been carefully considered with regard to their weight, and have been kept as light as is consistent with safety, but in the stationary portion of the engines material has not been spared to make them as rigid and steady as possible.

Governor Test.

Load.	How applied.	Speed.	Raised or lowered to r.p.m.	Variation in speed.
k.w.		r.p.m.		per cent.
677	Gradually on	206½	205	·73
812	,,	,,	203½	1·45
1010	,,	,,	202½	1·94
1030	,,	,,	202	2·18
1090	,,	,,	201½	2·44
1176	,,	,,	201½	2·45
1300	,,	,,	198	4·1
1380	Suddenly thrown off	200½	206½	3 increase
1310	Suddenly thrown on	206½	201	2·7 decrease

COMMERCIAL POSSIBILITIES OF LIQUID AIR.

THE question of the application of liquid air to useful purposes was not long ago actively brought before the public notice, not only through the medium of the Press, but as the result of demonstration, both in the lecture room and in places of public entertainment. The result of this is to cause great misunderstanding as to the commercial value of liquid air, both as a source of power and as a refrigerant. A theoretical consideration of the principles involved and the energy absorbed by its production and subsequently set free by its volatilisation and conversion to its original form of atmospheric air, may therefore not be out of place.

In the first instance, it may be as well to enunciate the law on which Dr. Carl von Linde, of Munich, bases the action of his now well-known "Counter-current Interchanger (Gegenstrom-apparat)":—"When any so-called permanent gas is allowed to expand without the performance of external work, *e.g.*, through an orifice or porous plug, then, owing to the increase which takes place in its internal energy, the expanded gas possesses a temperature below that of the gas previous to expansion." As a matter of fact, the drop in temperature in the case of ordinary atmospheric air amounts to 0·24 deg. Cent. for every atmosphere difference of pressure.

This may be expressed by the formula—

$$D = 0{\cdot}476\left\{\left(A - A_1\right)\left(\frac{493}{T_o}\right)^2\right\}.$$

Where D = reduction in temperature in deg. Fah.
T_o = initial absolute temperature in deg. Fah.
A = pressure (in atmos.) before expansion.
A_1 = pressure (in atmos.) after expansion.

The actual amount of cooling produced by such expansion of a "permanent" gas appears to depend on the ratio of the specific heats at constant temperature and pressure respectively.

In the apparatus employed by Linde for the liquefaction of air, the value of A is fixed at 200 atmospheres, as this is found to give the most economical results in actual practice. Of course, such a limit is purely arbitrary, but in determining it due attention has to be paid to the fact that, whilst the work performed in compression is a function of and depends upon the value of the ratio

$$\frac{A}{A_1},$$

on the other hand, the actual cooling effect produced as the result of expansion varies directly with the value of the expression

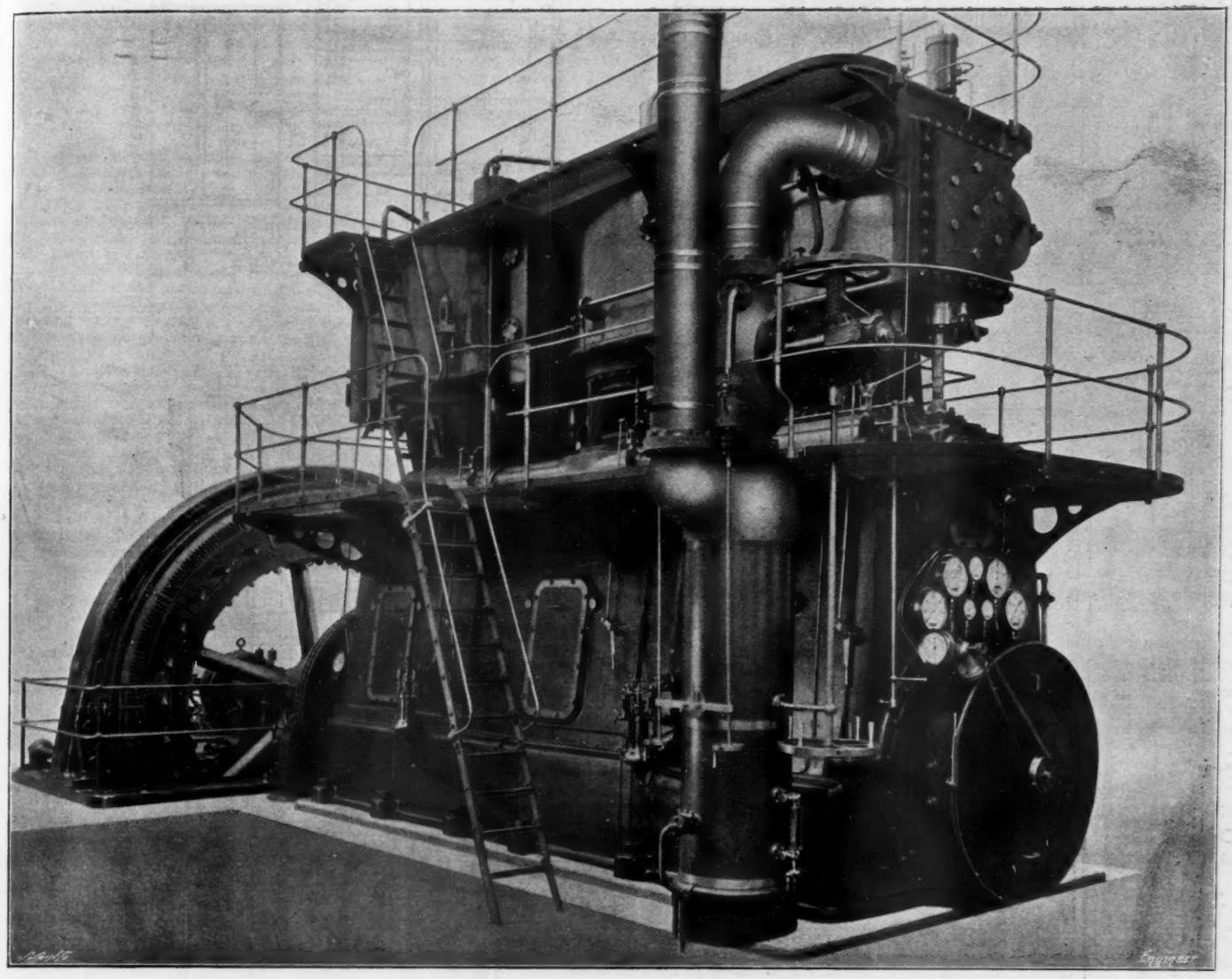
$$A - A_1.$$

It will be obvious that the general efficiency of the apparatus employed varies with the capacity of output. Certain sources of loss remain practically constant, whatever the size of the installation, so that the larger the capacity of output the greater the efficiency. The following table is prepared from actual figures obtained with five different sizes of installation working under generally similar conditions:—

1400-K.W. TRIPLE-EXPANSION ENGINE—LEEDS CORPORATION ELECTRICITY WORKS

J. AND H. McLAREN, LEEDS, ENGINEERS

(*For description see page 612*)



Capacity litres per hour.	Actual horse-power required.	Brake horse-power per litre.
5	12	2·4
25	50	2·0
50	90	1·8
100	160	1·6
200	300	1·5

For the purpose of the present examination it will suffice if the average of the above figures be considered, so that the production of liquid air may be taken as about:—

1·86 horse-power per litre per hour,
i.e., 8·73 horse-power per gallon per hour.

Or, taking 0·93 as the specific weight of liquid air, as:—

0·78 horse-power per pound per hour.

Considering now the application of liquid air to the generation of power, in the first instance it is necessary to assume approximately the conditions, *i.e.*, temperature limits, under which a "liquid air engine" could be worked practically. Now it is obvious that, dealing with liquid air as water in a boiler, some source of heat other than the combustion of fuel is applicable for evaporating the liquid. The question then occurs at once as to whether it would not be possible to utilise the heat of the sun directly through the medium of the atmosphere of the earth for this purpose. Theoretically there is no objection to this, given a sufficiency of draught and surfaces large enough to transmit the necessary heat with suitable rapidity. This, then, defines the value of T_1 in the expression

$$\frac{T_1 - T_2}{T_1}$$

for a perfect engine. So, therefore, T_1 may be taken as, say, 70 deg. Fah.

To obtain T_2, corresponding to the condenser temperature of a steam engine, suppose that a reduction of 20 deg. Fah. be possible, so that $T_2 = 50$ deg. Fah., which may be taken as the average deep-well water temperature in this country. Now,

$$W = p_2 v_2 \log. \frac{v_2}{v_1},$$

where

W = work done in foot-pounds per pound of air.
p_2 = final pressure of air in pounds per square foot.
v_2 = final volume of 1 lb. liquid air in cubic feet at the temperature of expansion (70 deg. Fah.).
v_1 = Initial volume of 1 lb. of liquid air.
$\frac{v_2}{v_1}$ = ratio of expansion from the liquid to the gaseous state at 70 deg. Fah. = 800 approximately.

From the above formula as basis is obtained the result that, theoretically, if 1 gallon of liquid air be evaporated and expanded in a perfect cylinder, it would be capable of developing about 1,900,000 foot-pounds, without allowing for losses.

Comparing this with the figures given above in connection with the power absorbed in production, the absurdity of the application is obvious.

It actually takes nine times as much power to produce 1 gallon of liquid air as can be, even theoretically, developed by 1 gallon of liquid air employed in a theoretically perfect engine.

As far as the application of liquid air to refrigerating purposes is concerned, this is equally impracticable. Take, for instance, the case of a small insulated cold chamber such as is used by butchers and provision dealers generally, and having a net cubical contents of, say, 800 cubic feet. To maintain such a cold chamber at a temperature of from 35 deg. Fah. to 40 deg. Fah., a refrigerating plant capable of eliminating about 9000 B.T.U. per hour would be employed in ordinary practice. Such a plant on the ammonia compression system would require about 1½ brake horse-power to drive it, or if carbonic acid be the refrigerant employed, the power would be, perhaps, somewhat in excess of this, amounting to, say, 2 brake horse-power.

Now, according to Dr. Linde, in the case of liquid air, the total heat required to evaporate one pound of liquid air at atmospheric pressure, and to raise the temperature of the resultant vapour to 35 deg. Fah., is 342 B.T.U.

Consequently, assuming the application of liquid air to the above stated case of a butcher's safe, in order to approximate to what may be termed normal conditions of working, and assuming no source of loss, then to eliminate 9000 B.T.U. per hour—the duty of the refrigerating plant in this case—a consumption of over 26 lb. of liquid air per working hour would be necessary. This corresponds to a power consumption of more than 20 brake horse-power, or more than ten times as much power as is required in the case of a carbonic acid machine for the same duty.

Moreover, apart from the extra power required to drive a liquid air refrigerating plant compared with a carbonic acid machine, the initial outlay in the former case is many times greater.

It must, however, be acknowledged that, notwithstanding the foregoing figures, there are great possibilities in the future for the application of liquid air to the arts. This is the more readily appreciated if it is borne in mind that by a very simple process of "fractionation," owing to the difference in the boiling points respectively of liquid nitrogen and oxygen, a gas which is practically pure oxygen (95—98 per cent.) can be obtained at a comparatively low cost. Furthermore, owing to this difference in the boiling points of the principal constituents of the atmosphere, liquid air as normally produced is actually much richer in oxygen than ordinary atmospheric air. This property renders it in certain cases particularly applicable to the following processes, among others:—

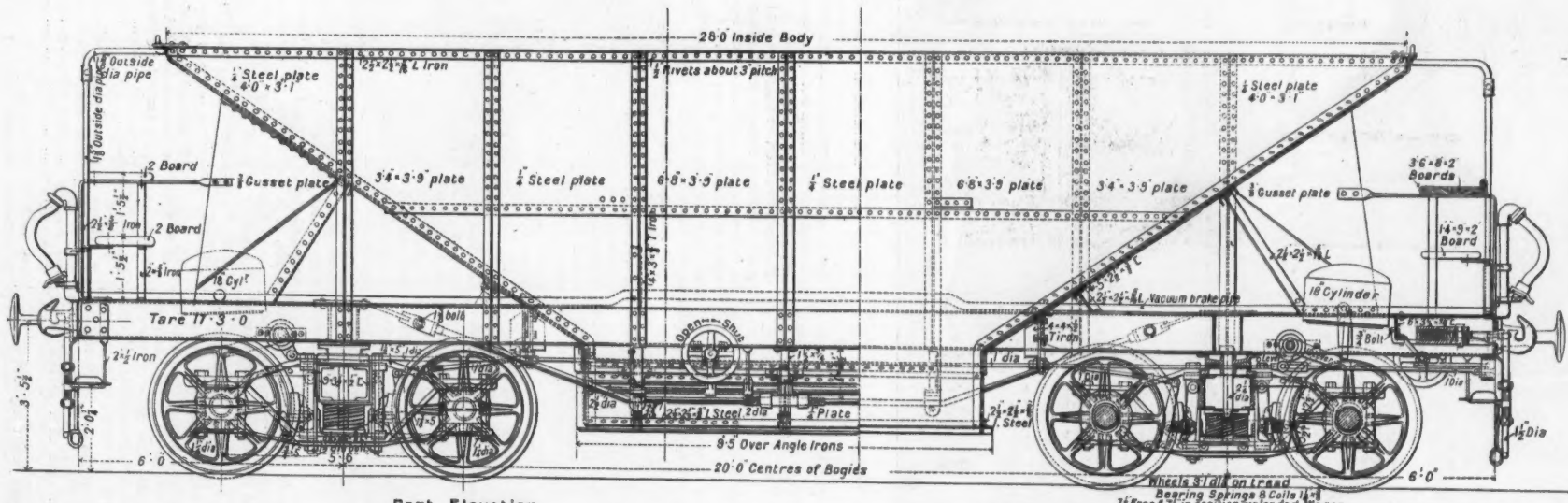
(1) *The manufacture of producer gas.*—In an article in *Chemische Industrie* Professor W. Hempel, of Dresden, describes the use in gas making of a mixture of half oxygen and half nitrogen, which is attained by liquefying air in a Linde machine, and allowing the liquid air to evaporate its nitrogen partly away. He states that the half-and-half mixture can be made at a working cost of 4d. per thousand cubic feet by evaporating the remaining liquid, and it can be applied in two ways, either for making oxygen producer gas or oxygen water gas. In both of these gases the great advantages of internal heating are secured, but the heating values are relatively low, owing to the excess of nitrogen in the product. Producer gas is made, as is well known, by passing air through glowing coke to form CO—carbon monoxide—and N_2—nitrogen. If, however, instead of air, 50 per cent. oxygen be used, the results are considerably affected, as indicated in the following table:—

Constituents.	Ordinary producer gas. Volumes equal per cent.	Oxygen producer gas. Volumes.	Per cent.
CO_2	3·4	3·4	6·1
Heavy hydrocarbons	0·8	0·8	1·4
O	0·3	0·3	0·5
CO	25·4	25·4	45·9
CH_4	5·3	5·3	10·7
H	6·8	6·8	12·3
N	57·4	12·7	23·0
	99·4	54·7	99·9

FORTY-TON BALLAST HOPPER WAGON, LONDON AND SOUTH-WESTERN RAILWAY

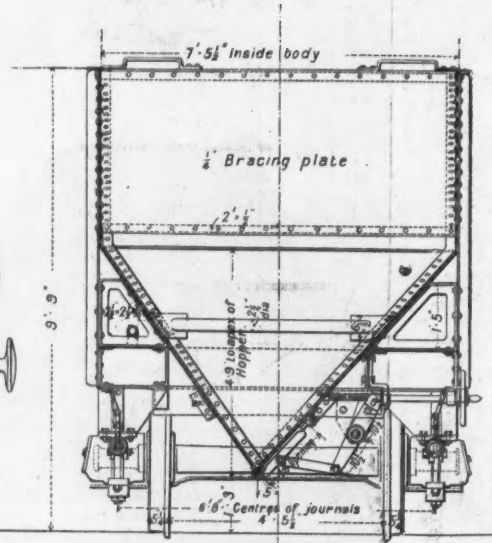
G. R. TURNER, LIMITED, NOTTINGHAM, ENGINEERS

(*For description see page 628*)

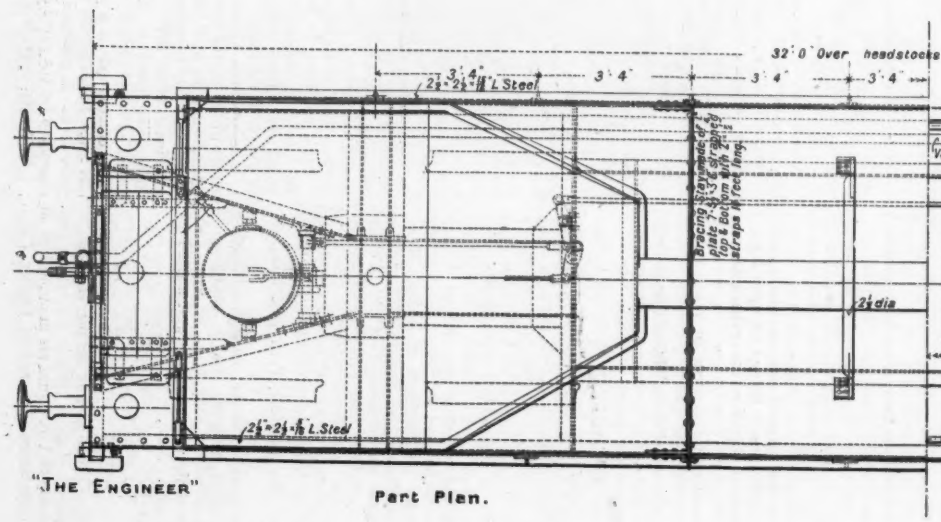


Part Elevation.

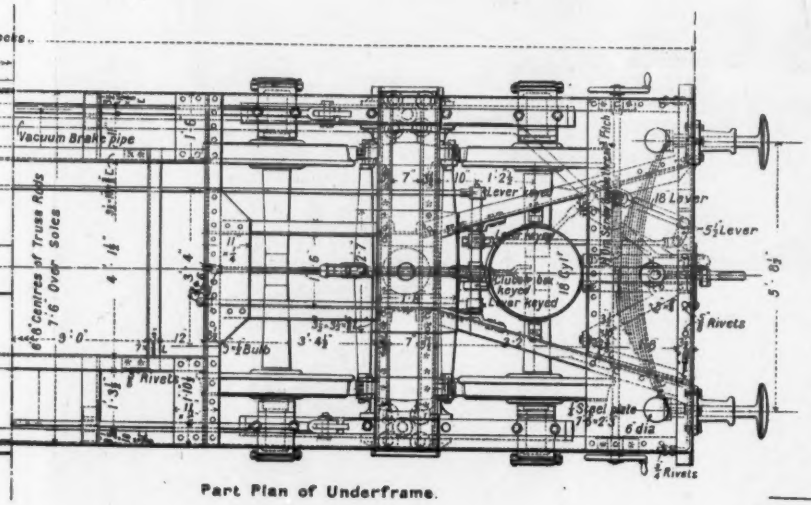
Part Longitudinal Section.



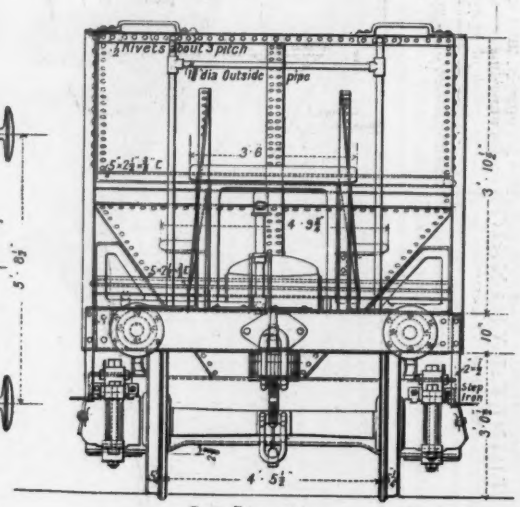
Cross Section.



Part Plan.



Part Plan of Underframe.



End Elevation.

SWAIN Sc.

These results are only approximate, and would be affected by the nitrogen taken in along with the production of CO_2, but, on the other hand, the production of CO_2 would be diminished on account of the higher temperature in the producer.

(2) *The manufacture of water gas*, which is normally generated by passing a mixture of air and steam over glowing anthracite or coke, as in the Dowson process. Without going into details, it may be stated that a very great benefit is obtainable by the use of a 50 per cent. oxygen in place of ordinary air, as indicated by the figures in the following table:—

Constituents.	Ordinary water gas.	Water gas from 50 per cent. oxygen.
H	12·1	25·3
CO	28·0	58·3
N	59·9	16·4

These figures are approximate, as in practice there would be some CO_2 but less marsh gas and ethylene.

(3) *The manufacture of explosives.*—When liquid air is brought into intimate contact with some easily oxidisable vehicle, such as coal dust or charcoal, the resultant mixture possesses the peculiar property of exploding with extreme violence by detonation. This method of blasting has actually been employed in the construction of the Simplon Tunnel. Under certain conditions it might prove extremely economical, and it is certainly safer than any other known method, as after a short period the liquid air has entirely evaporated and the cartridge is then quite inert.

(4) For illuminating purposes with incandescent mantles, a great increase in candle-power can be obtained. On a large scale it may be assumed that the cost of production per cubic foot is the same as that of a cubic foot of town gas, whilst the candle-power obtained with a lamp such as the Nürnberg is increased from 1 with ordinary town gas to 5 with a mixture in equal parts, showing a net saving of 2½ to 1.

(5) The application of liquid air to the manufacture of calcium carbide, it is estimated, would in certain cases appreciably reduce the cost of production.

There are numerous other possible applications of liquid air to various industries, but first and foremost is its application to the cheap production of oxygen, as previously referred to, by fractionation. It is impossible to foretell what effect this may have in reference to the practical development of many processes in which oxygen is largely used at present, but it cannot fail to have great influence in many cases.

THE INSTITUTION OF MECHANICAL ENGINEERS.

A MEETING of the Institution of Mechanical Engineers was held last Friday evening at the Institution in Storey's-gate, the President, Mr. Wicksteed, being in the chair. There was a large attendance present to hear the paper on "Heat Treatment Experiments with Chrome-vanadium Steel," by Captain H. Riall Sankey and Mr. J. Kent Smith.

After the minutes of the last meeting had been read, the ballot, which had been previously opened by the Council, was declared, and eight members, 33 associate members, and 19 graduates were elected. Two transferences from associate members to membership were also made. The Secretary then read extracts of the paper, of which we give here a special abstract.

A few brief tests are given, taken from a large series of experiments made on different "alloy" steels manufactured at Messrs. Willans and Robinson's Ferry Works, Queensferry, Flint, one of which was chosen for further investigation owing to its excellent results, not only in tension tests, but also in bending, twisting, and welding tests, and to its commercial possibilities. This steel was repeatedly made in quantity on the open hearth, and when it was proved that such steel, having all the good qualities of the trial sample, could be consistently prepared commercially from the furnace, the experiments which led to the above paper were carried out on a cast of it, the ingots being rolled to 1¼in. rods in the usual way.

It was originally intended merely to repeat upon this steel the series of tests carried out by the Alloys Research Committee, and reported by them in their Sixth Report to the Institution of Mechanical Engineers, but subsequently it was decided to add many other tests on the steel, after subjecting it to the various thermal treatments above mentioned, impact, torsion, alternation, bending, twisting, and other tests being included. An addition was also made of the results of such tests applied to samples of other casts of similar vanadium steel, to samples of several other kinds of different open-hearth vanadium steel, to a sample of crucible vanadium spring steel, and to several samples of nickel and other steels.

Some of the results obtained led the authors to investigate the readiness of the impact test—the impact being of sufficient force to break a notched sample at one blow—in reference to the microstructure of the same steels. A thorough comparison of the various fractures resulting from static and dynamic rupture was made, and the results of these investigations and comparisons are given in the paper.

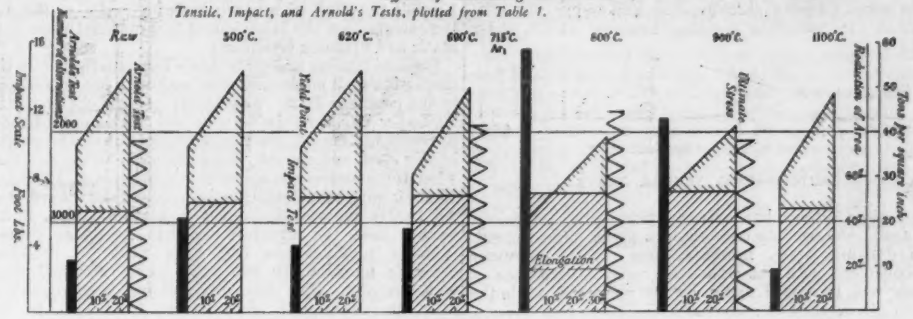
The paper of Mr. J. E. Stead, presented to the Iron and Steel Institute in September, 1903, suggested an investigation into the possibilities of "restoring" this particular steel by heat treatment; and results of these trials are given in the paper and were added to verbally. Micrographs of this steel partially decarburised, showing the effect of overheating and subsequent degrees of reheating upon the base structure, massing and diffusion of carbides are published, and further micrographs were laid before the meeting, showing the effect of such restoration on the carbide constituents of the steel reheated in bulk.

Various micrographs showing the changes produced in the structure of badly annealed ordinary forging steel, and of overheated tube steel, by suitably reheating, as also a composite micrograph demonstrating the advisability of annealing in some cases at a heat well below the main point of retardation, are also figured in the paper.

The temporary cessation of the manufacture of steel at Queensferry, from circumstances quite unconnected with vanadium steel, suspended further production of this steel and its exploitation for commercial purposes. At the time of writing these steel works are restarting, hence this material may be obtained in quantity.

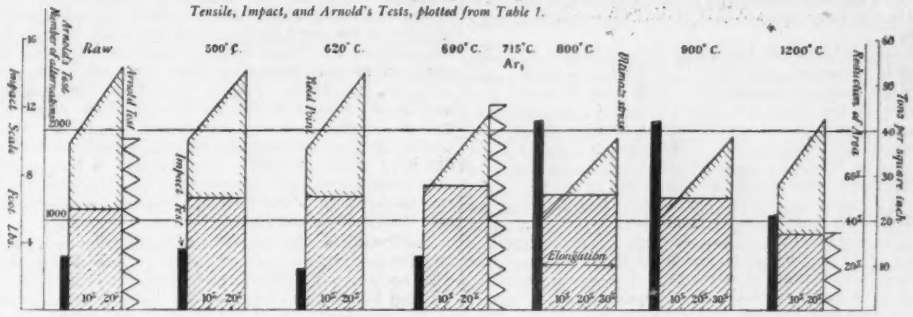
Effect of Annealing Cr Va *Steel.*

Tensile, Impact, and Arnold's Tests, plotted from Table 1.

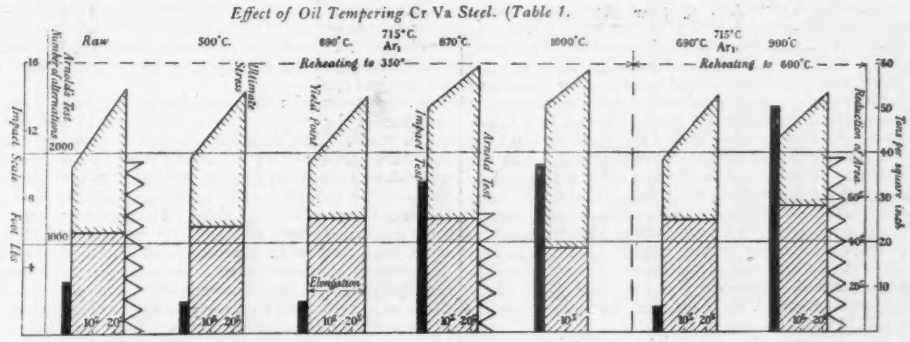


Effect of Soaking Cr Va *Steel.*

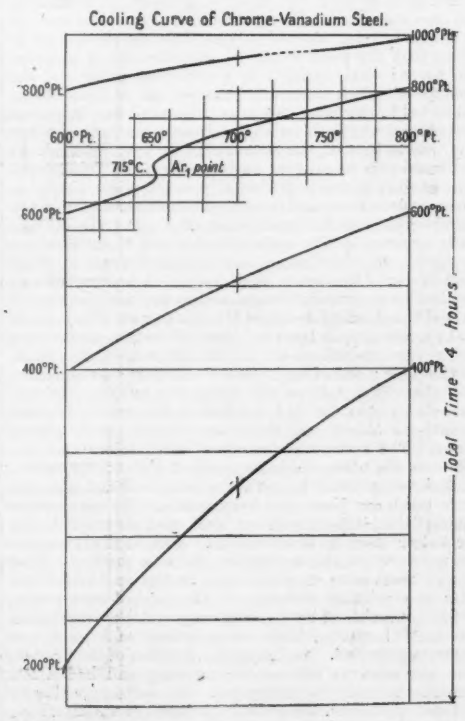
Tensile, Impact, and Arnold's Tests, plotted from Table 1.



Effect of Oil Tempering Cr Va *Steel. (Table 1.*



Cooling Curve of Chrome-Vanadium Steel.



The results of the various tests, after different thermal treatments of the materials named, are given in detail in a series of tables, analytical particulars of these steels being also given in tabular form. These various results are synoptically summed up in five plates, whereby the yield point, maximum stress, elongation, contraction, resistance to alternation and to impact, and the microstructure of the steel after its different thermal treatments can be seen at a glance. Micrographs of the more representative treatments are also published at high magnifications, as are also a number of micrographs of vanadium spring steel, nickel steel, and other steels, under various conditions.

A cooling curve, determined by the electric resistance method, is given of the chrome-vanadium steel experimented on in the main, and other figures are given illustrating the various autographic records obtained, curves comparing the various dynamic tests, and some comparative curves of the static behaviour of this steel and of the ·468 per cent. carbon steel of the Alloys Research Committee. Further tests were verbally communicated to the meeting by Captain Sankey.

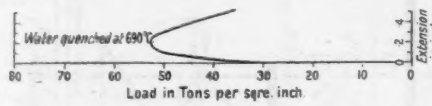
The paper is illustrated by eight figures and eleven plates.

From the mass of results which the paper contains we arrive at the following facts:—

(1) That in this raw chrome-vanadium steel—the type is styled Carl 349 in the paper—well rolled or forged in the ordinary way, or preferably in such steel annealed well below its retardation point so as to remove forging strains, *i.e.*, at a blood-red heat, we have a material of enormous static strength and ductility. Under tension tests the yield point is about 37 tons per square inch; the maximum stress about 54 tons per square inch; the elongation about 25 per cent. on 2in.; and the contraction of area nearly 50 per cent. With these high tensile properties the steel behaves under bending and twisting like a mild steel of excellent quality—¾in. square bars and 1in. round bars being shown which had been bent close double. It can be welded. It has a power of resisting alternations of stress greatly superior to that of good quality forging steel, as determined by Professor Arnold on his stress-strain machine. Some of the figures published show nearly 100 per cent. increase. Its resistance to fracture by bending is more than double that of excellent steel which has only half its strength. Subjected to impact, the blows of which are not sufficient to produce serious distortion, a notched bar tested by Messrs. Seaton and Jude on their machine—Institution Mechanical Engineers, November 18th, 1904—under their standard conditions, shows as great a resistance as excellent steel having only about half the strength of the chrome-vanadium steel. The number of blows registered is twenty-four. Its powers of resisting torsional strain are enormous; a piece under standard conditions—6in. length, ·75in. diameter—twisting 3·9 times before parting. Its power to resist fatigue has been demonstrated in practice over twelve months, severe trials on several tons of material being used for the various purposes. This steel has in many cases succeeded where all other steels tried have failed.

(2) By annealing—reasonably speaking, of course—

above the main recalescence point—say, at 800 deg. Cent.—a considerable amount of the static resistance to stress is sacrificed, though the static ductility of the material is further increased. The material in this condition is still, to tensile tests, much superior to ordinary forging steels of good quality; in fact, it is comparable to a 3 per cent. nickel steel of good quality. It gives about 21 tons per square inch yield point, 38½ tons per square inch maximum stress, 34 per cent. elongation, and 53 per cent. contraction. Its power of resisting torsional strain, under



AUTOGRAPHIC TENSILE TESTS

standard conditions, has increased from 3·9 to 4·6 twists. Naturally, the bending tests show a great improvement. The dynamic tests, however, here show enormous improvement, and the power to resist alternations of stress was increased again by 50 per cent., while the power of a notched bar to resist impact under Messrs. Seaton and Jude's conditions shows a figure three times as high as the raw, while the power to resist impact when the blow applied is sufficient to break it at one application is now fully equal to that of the best Swedish mild steel.

(3) By suitably oil tempering the material the elastic limit is increased, and the whole of the original static strength may be maintained, while the dynamic properties of the steel are also almost at a maximum in many cases. By oil quenching at 870 deg. Cent. and tempering at 350 deg. Cent., the material shows a yield point of 49·8 tons per square inch, a maximum stress of 59·3 tons per square inch, an elongation of 23 per cent., and a contraction of 50 per cent. The ductility, as evidenced by hand bending, while still equal to that of good forging steel of "30-ton strength," is not so good as in the raw vanadium steel, and the difference of its power to resist alternations of stress is in the same direction, but a little more marked. The impact figure, however, shows good and regular. By oil quenching at 900 deg. Cent. and tempering at 600 deg. Cent., a material is obtained having a yield point of 43·4 tons per square inch, a maximum strength of 53·6 tons per square inch, an elongation of 22 per cent. and a contraction of 56 per cent. The static ductility is further evidenced by the fact that a ¾in. round was in this state bent double. The resistance to alternation of stress is equal to that of the original steel; the resistance to impact under Messrs. Seaton and Jude's conditions remains equal to that of the steel in the (800 deg. Cent.) annealed condition—the figure is 76—and the resistance to impact to one excessive blow is equal to that of pure, mild, Swedish tube steel. The above combination is, to say the least of it, an extraordinary one.

(4). By quenching out the steel from a high temperature the authors made many cutting tools of very satisfactory quality. No difficulty was experienced in turning crankshaft steel at 50ft. per minute, giving a cut of $\frac{3}{32}$in. Thus, in the same material, we have the characteristics of a dead mild steel and a live steel.

(5) By subjecting the material to a high heat—short of true chemical burning, of course—it is demonstrated that a piece of the steel soaked at a temperature of 1200 deg. Cent. for three hours is not absolutely ruined, though it is deteriorated.

A material is obtained having an ultimate stress of 46·8 tons per square inch, an elongation of 19·5 per cent., and a contraction of 31 per cent. The impact figure is about half that of the original steel, and the resistance to alternations of stress has diminished by about 25 per cent.

On soaking at 1200 deg. Cent. for twelve hours the ultimate stress becomes 42·5 tons per square inch, the yield point being 28 tons per square inch, the elongation and contraction percentages being almost identical with the three hours' soak. But the resistance to alternations of stress has further decreased considerably, being now 60 per cent. below that of the raw steel.

By suitably reheating the steel thus received, the yield point rises to 35·8 tons per square inch, the maximum stress to 52·7 tons, the elongation to 22 per cent., the contraction to 48 per cent., the resistance to impact becomes similar to that of the original steel, and to alternations of stress only about 15 per cent. less than that of the original steel. The appearance of the microstructure and of the fracture entirely alters.

In other words, the steel is practically restored, after being heat-ruined, to comply with all the original tests. The practical restoration to alternation resistance is the most striking of all the above figures.

(6) Among many other chrome vanadium steel results quoted, a steel having an ultimate stress of 36 tons per square inch, a yield point of 23 tons per square inch, an elongation of 30 per cent., and a torsion result under standard conditions of over 4·9 twists before rupture, is alluded to.

(7) Particulars of a chrome vanadium spring steel, as compared with a spring of excellent quality, are given; the chrome vanadium spring has double the coefficient of the ordinary spring for a safe working load.

(8) A lengthy comparison of impact results, as related to the micro-structure of the metal experimented on, is made. Briefly, the conclusions drawn are that with a structure consisting of pearlite in considerable quantity, surrounded by ferrite, the impact on a notched bar is found to give a fair but variable figure as to the foot-pounds of energy absorbed in breaking a standard-sized specimen; when the structure becomes one of ferrite more or less surrounded by sorbitic pearlite, or when it is granular and diffused, the impact figure is good and regular; when the structure is martensitic, the impact figure is regular and bad.

Without careful study of the paper *in extenso*, it is difficult to realise the amount of labour involved in its composition. The authors have gone into the details of the question very fully, but are content to give results without advancing theoretical or controversial views. But they hold that the combination of figures quoted, together with severe practical tests extending over twelve months, on several tons of material, justify them in claiming that such material itself is quite out of the common; while the aim of the paper is to show as completely as possible the effect of a widely differing series of thermal treatments upon the behaviour of that material under both static and dynamic conditions.

Captain Sankey wished to add a few remarks before the discussion took place, and after making a few corrections in the paper, took the opportunity of publicly thanking Professor Arnold for the tests he had carried out for them at Sheffield. He also dwelt upon the remarkable properties of this steel, and specially drew attention to the fact that when the material was soaked for three hours at 1200 deg. Cent., it gave considerably better results than when soaked for twelve hours at the same temperature. Also, in the former case, the structure was not nearly so ruined. Various modifications had been made in Professor Arnold's machine for this case, which modified some of the results. One alteration that had been made was that the stroke had been altered from 1¼in. to 2in. Although these alterations were only small, he pointed out that the results, in order to be comparable with the rest, must be multiplied by two, thus bringing the value to approximately 1600. He also drew special attention to a box of fractured specimens of this steel—which had been broken by impact-testing apparatus—because the results were most interesting. The results referred to were given in the paper. Finally, he wished to say that the part he had played in the production of the paper was that of compiler, and the credit was due to Mr. Kent-Smith for the micrographs, and the experiments which had been made generally. He thought it was almost unnecessary to remind the members that Mr. Kent-Smith was the inventor of this class of steel, and spent considerable time in its development.

The President, after thanking the authors for their paper, and having passed a vote of thanks, which was greeted with acclamation, said he had received a letter from Sir William Roscoe, who regretted his inability to be present at the meeting, as it is a subject in which he has been interested for fifty years. It would be remembered that Sir William Roscoe was one of the first—if not the first—to separate vanadium. Continuing, the President said he would like to remind the members that Messrs. Seaton and Judes' paper was also open to discussion, as well as the one just read.

Dr. Carpenter, who was asked by the President to open, commenced by referring to a statement in the paper which reads, "The National Physical Laboratory determined the recalescence point of this steel by a differential method, and made the average 705 deg. Cent.—1301 deg. Fah.—with a temperature of maximum intensity of about 740 deg. Cent.—1364 deg. Fah." He thought there may some doubt as to how these figures were arrived at, and stated that they were obtained from the cooling curve. The authors also discuss recalescence determinations in the paper, and a paragraph appears which runs as follows:—"It is worthy of note that the average recalescence point of three closely agreeing cooling curves of cast 349 . . . agrees to within a few degrees with that determined by the National Physical Laboratory with a piece of chrome-vanadium steel from cast 145, which has the same chemical composition and mechanical properties. Only one marked retardation point on each curve could be found either by the differential or the thermo-electric method." Dr. Carpenter said that the last remark was incorrect, as both methods adopted were thermo-electric.

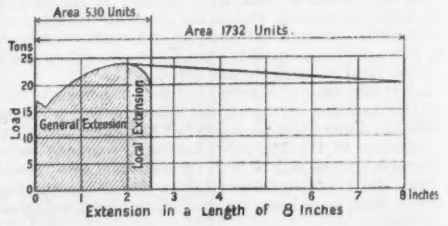
The next speaker, Mr. Howton, confined his remarks to the previous paper. He considered that the ideal method to break any bar was to subject it to the same kind of stress that the piece would be subjected to in practice. He agreed that ductility is a sufficient guide for the quality of steel. As an example of a shaft being subjected to the same effects as a notched bar, he gave a propeller shaft; in this case the stresses are not related in any way to tension, but to shocks of the severest kind. As an illustration to confirm this statement, he pointed out that engineers much preferred iron propeller shafts to those made of steel, and it is a significant fact that iron will stand shock tests far better than steel will. He did not quite agree with the authors that shock tests were not applicable to boiler plates, and he quoted a case in which he had found the test to be of value. A boiler plate had cracked for no apparent reason, and, as the steel was as good as could be obtained, he asked Messrs. Yarrow if they would make a few impact tests for him. Four test pieces were taken, two notched on the outside and two on the inside of the plate; one of each class of notching was annealed, and the other left in the normal condition. Of the annealed plates the one notched on the outer side stood twenty-six blows, and the inner notched one eighteen blows. The normal plates stood three blows and five blows on the outer and inner notched plates respectively, thus showing that although the tension tests and analyses were good, the plate was very brittle. He emphasised the fact that impact tests on mild steel show brittleness far better than tension tests do. And, finally, he urged the necessity for standardisation for this method. That impact tests were of great value he had no doubt. But with the existing variation in the size of test pieces, notches, number of blows, frequency, and the weight used, the results were of little value unless each case was separately studied. Mr. Longridge, member of the Council, was the next to address the meeting, and had a few remarks to make on each paper. He quite agreed with the last speaker on the great importance of standardising the test bars and the methods of carrying out impact tests, as at present they were in a most unsatisfactory state. He gave three interesting cases of fracture in which he thought that, if impact tests had been made, they would have been of value. The first was a broken connecting-rod which broke ⅛in. from the thread, the fracture being quite smooth and uniform. Secondly, the link of a beam engine; and lastly, a boiler plate. In this case the chemical analyses showed the steel to be a good one; the tension tests were equally satisfactory; so he decided to send test pieces to Professor Arnold at Sheffield, who examined them, and reported that there existed "potential brittleness." This, Mr. Longridge thinks, might have been discovered in the first instance by suitable testing. He considers that the section of the test piece at present adopted is not the correct one, as it ought to be circular in section and about ¾in. diameter. In the square section at present used the edges are frequently rough, and then the bar gives sooner than it would otherwise do. With regard to Captain Sankey's paper, it was not at all clear to him, and the only deductions he could draw from it were that if you want the steel to stand resistance to shock and alternating stress, all that is required is to heat it to 900 deg., and cool it with anything but water. He would therefore like to ask the authors if this was what they really meant.

Professor Harbord commenced by referring to the method of making tests in bulk for such materials as rails, and stated how expensive it was, and how much better it would be if some simple means—as in the case of impact tests—could be adopted, but at present the great objection lay in the irregularity of the results, at least, so far as could be deduced from the tests made some four years ago by Breuil and Volga. He would like to ask Mr. Seaton if he obtained the same irregularity. The method adopted by Breuil and Volga was then briefly described, which consisted of clamping one end of the test piece firmly in a vice and allowing a weight to drop on the free end. With regard to the question of notching the bars, he pointed out that Breuil and Volga had come to the conclusion that it was better to leave the bar quite plain, with no notch of any description. He asked Mr. Kent-Smith if he could say how much the vanadium and how much the chromium respectively had to do with the properties of this class of steel, as the data, if it could be given, would be very interesting. In Professor Arnold's criticism of Mr. Seaton's paper at the last meeting, he—Professor Arnold—had objected to the term "eutectic," and substituted the word "saturated," with regard to the amount of carbon in steel. Professor Harbourd considers the term "eutectic" as quite a legitimate one, as it tells one exactly the whole physical structure of the steel, whereas "saturated" only tells one something about the percentage of carbon. And with reference to the other terms Professor Arnold used, he thought that they ought not to have been mentioned, as they were only used once or twice, and were not accepted terms. He said it was wrong to make those assertions, as we owe a great deal to the originators of the word "eutectic."

Dr. Stanton added a few remarks to those he had already made on impact tests at the last meeting. He has had samples of steel supplied, and found that one broke after one blow and yet stood a shock of 50 per cent. greater than one that stood forty-three blows. They had been tested under quantities worked out by the "proof resilience" formula, and there was no permanent set. When the load was increased about 25 per cent. greater than that calculated from the equation there was deformation of the bar.

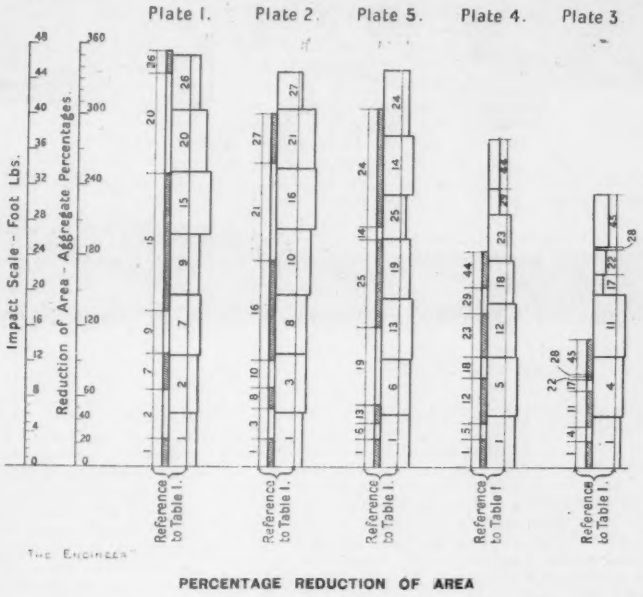
Mr. Blount wanted to know if anything could be added to the methods of testing that could tell us what cause there is for disease in steel. He thinks Professor Unwin is wrong in assuming that mild steel is a homogeneous material, and considers it more analogous to a muscle, and both the molar and the micro structure—the latter corresponding to the nerves—must be considered. On the question of standardisation of impact tests he was of opinion that very many more experiments must be made before any definite conclusions are arrived at, as at present our knowledge is not sufficient to justify the standardisation of impact tests.

Mr. Wicksteed said that he did not think impact had the slightest effect on a piece in breaking, and he did not think that impact on a notched piece would tell anything that could not be better told by steady loading. Experiments were made by Colonel Maitland in 1867 to ascertain the effect of sudden loading or shock as follows:—"A strong tube was prepared by being accurately bored and furnished in the middle with a radial vent and a radial pressure gauge. Plugs of steel fitting the bore of the tube were screwed on to each end of the specimen. These plugs were fixed in the tube, the annular space around the specimen being filled in some cases with quick burning powder, and in others with gun-cotton air-spaced. On the charges being exploded through the vent



the plugs were driven violently out of the tube in opposite directions, each carrying one half of the specimen. The elongations under these tests varied from 47 per cent. to 62 per cent. The fracture in all cases was silky and fibrous. With the largest charges of gun-cotton tried, giving presumably the most sudden strain, the specimen in several places broke in two places, the central piece being cigar-shaped. This unexpected result of increased suddenness of strain giving increased elongation is probably due to the metal not having time to settle, as it were, in what spot to break. Under gradual tension the specimen was stretched very locally, and broke at the spot least able to sustain the strain. Under sudden ten-

sion the specimen stretched all over the operative part." The President here referred to the diagrams which he had placed on the walls of the theatre. One of these was a typical diagram of a piece which reached the strength limit at a point A, and then reduced its area by 50 per cent. Another diagram referred to a piece of material which went up to the highest strength limit and then broke without reducing its area locally. This latter would be brittle material, and the former would be ductile material. It was possible to draw the distinction just as well without the notch as with the notch; notching the specimen simply made it break locally. An unnotched bar broke where it chose to break, with a constricted area. If a piece of bar 8in. long would reduce uniformly 50 per cent., it would elongate 100 per cent. Therefore if a bar were reduced all over its length—which would be getting all the work out of the bar that was in it—the bar would give, before it would rupture the particles asunder, in a bar 8in. long, instead of 2½in. extension, an extension of 8in. This result was plotted on the diagram to exactly the same scale as the usual part of the diagram. The area of the usual diagram showed 58in. tons, but the extended area showed 178in. tons. That would bring home the significance of local extension, which was alluded to in the papers, if at all, as if it were not much to be regarded. It was, however, the particular point which marked the difference between materials that would or would not stand nicking. Whether the stress were by impact or by a steady transverse stress was not of the slightest importance. The material would stand the amount of work which it had in it, as shown by the whole area of the diagram if every section of the material were stretched up to the point when the particles would no longer cohere. The speaker arrived at his conclusion by a study of Captain Sankey's and Mr. Kent-Smith's paper. Refering to Plate I., on preceding page, and confining his attention to percentage of reduction of area, Mr. Wicksteed noticed that the sample in the raw state, at the left-hand of Plate I., had a low percentage of reduction of area. Progressing from 500 deg., 620 deg., 690 deg., the point 715 deg. C. was reached, where would be seen the higher line representing the reduction of area. Passing to the point 800 deg. C., the next highest results were reached, as indicated by the diagram, and there was a descent until the point of 1100 deg. C. was reached. In the experiments illustrated in Plate II. the same thing occurred. Working up the strength to 715 deg. C., where the higher line denoting impact occurred, there was also higher reduction of area. In Plate III. again the same thing was conspicuous, the reduction of area at 1200 deg. C. was but 1·5 per cent., so small that it could hardly be seen in the figure. In Plate VI., Fig. 4, it would be found that the highest line showing the number of blows corresponded with the highest line showing the percentage reduction of area. Since the meeting, Mr. Wicksteed has supplied us with the subjoined diagram, which shows Capt. Sankey's Plates I. to V. with the total height of all the impact lines on each plate combined, and the total height of the scale readings of the percentage reduction of areas combined, and this shows that their characteristics follow each other on the average very consistently.



On being called upon by the President to reply, Mr. Seaton said that the bulk of the answers to the various questions would be sent in writing to the secretary, as at that late hour in the evening he had not time to deal with them then. He said he also knew of a case similar to that of Mr. Longridge's, in which a plate failed under hydraulic pressure before it reached the test point, and the fracture did not start at a rivet hole. The chemical analysis proved to be a good one, the mechanical tests were good, and Professor Arnold could not find anything the matter with the plate, so he had consequently been unable to give any satisfactory explanation of the failure. With regard to the President's remarks on notches, he explained that they were introduced to subject the material to similar stresses, were found in everyday use, and what had been said in the paper fully justified their use. He explained how parts were broken by small shocks applied thousands of times, and the shock that broke the piece was nothing like as great as the one that would be required to break the same piece when new with a few strokes. He quite agreed with Mr. Longridge on his remarks concerning the correct section of the bar, as he was also in favour of a circular section. With regard to the weight used, Mr. Yarrow used a much heavier one than they had adopted, and he thought it was better to use a light one and apply many more blows. In answer to Professor Harbord about the irregularity of results, they had found very little variation with the same material, although in the case of bright steel rolled shafting there certainly was not the same regularity. There could be no doubt whatever as to the question of standardisation if the tests were to become recognised. One speaker had suggested that if the bar broke with twenty-four blows, it was four times as strong as one broken in six blows, and had asked if this was correct. In reply, Mr. Seaton's answer was "No." The bar which broke with twenty-four shocks was certainly stronger, but not in the proportion of 4 to 1. As to the method of breaking the bar, they aimed at doing so simply by shock, without introducing bending at all. Sir William White had suggested that it was unnecessary to keep on testing, but he—Mr. Seaton—did not agree with him. It would be very nice if they could rely on the same quality of material being supplied, but this was impossible. In conclusion, he wished to thank everyone for the interest they had taken in the paper, and again explained that he did not in any way suggest that their method was the correct one, or the one that was to be followed. They had prepared the paper simply as a means of bringing this subject prominently before the Institution in order that some good may result from the discussion.

Mr. Kent-Smith, who had only a few minutes in which to reply, said he would answer most of the questions in writing. He referred to Dr. Carpenter's remarks on the thermo-electric and differential methods for recalescence determinations. He knew they were both the same, and considered that they ought to have substituted "electric resistance" method, as it was a more suitable term. With regard to the tests at the critical temperature, he would give some interesting results, in the report, that had recently been obtained at temperatures varying from 690 deg. to 720 deg. Dr. Carpenter had only been able to obtain one retardation point, but Mr. Kent-Smith stated that they—the authors—had certainly obtained two. In answer to Professor Harbord as to how much the percentage of vanadium and chromium respectively was responsible for the physical properties of the steel, Mr. Kent-Smith explained that by increasing the amount of the latter, a higher stress was obtained, and with a static stress of 38 tons per square inch the steel practically keeps the ductility of the raw material.

MOTOR CARS IN PARIS.

No. II.*

IF the motor car has undergone little alteration during the past year, there is less change observable in the internal combustion engine than in any other part of the mechanism. The many problems that occupied the attention of automobile engineers a year ago have been dropped, either because they did not seem to offer a satisfactory solution or because manufacturers have taken no heed of principles which it was thought would assist in increasing the efficiency of the petrol motor. The building of engines has settled down to a general practice, without makers being always able to give any definite reasons why one method should be employed in preference to another. To take compressions, for instance, it is evident that high compressions give a greater efficiency to the engine, but in the case of motors that have frequently to be started by manual labour the advantages of the system are somewhat negatived by the difficulty of bringing the piston up on the compression stroke. It also means that the engine has to be specially designed to resist higher strains on all its moving parts. If comparatively low compressions have to be used for the sake of convenience, some makers have tried to improve the engine efficiency by placing the inlet valves on the top of the cylinders, so that the explosion will give a direct impact on the piston, instead of the charge being fired by a horizontal flame from a side valve chamber. In other words, the explosion is more rapid. For the same reason, certain makers give a dome shape to the combustion space, so as to concentrate the charge over the piston. This practice of admitting the gases at the top of the cylinder necessitates an arrangement of stems and tappets which imparts a somewhat complicated appearance to the engine, but there are still several firms who hold to this system, and argue that it gives a higher efficiency. In a general way there is a tendency to pay more attention to simplicity by suppressing long stems and tappets, and the majority of motors have valve chambers on each side of the cylinders, with the valves underneath. In the new Belgian Pipe engines the valves are inclined at an angle of 45 deg. from the cylinders, so as to allow of a curved passage for the fresh gas entering the cylinder and for the exhaust on leaving, the idea being that this offers less resistance to the gases than when their direction is changed by the usual position of the valves. This is an instance of how little things will influence the design of engines, and it is really difficult to say how far these attempts to secure slight advantages by the use of heavier valve gear is justified.

* No. I. appeared December 16th, 1904.

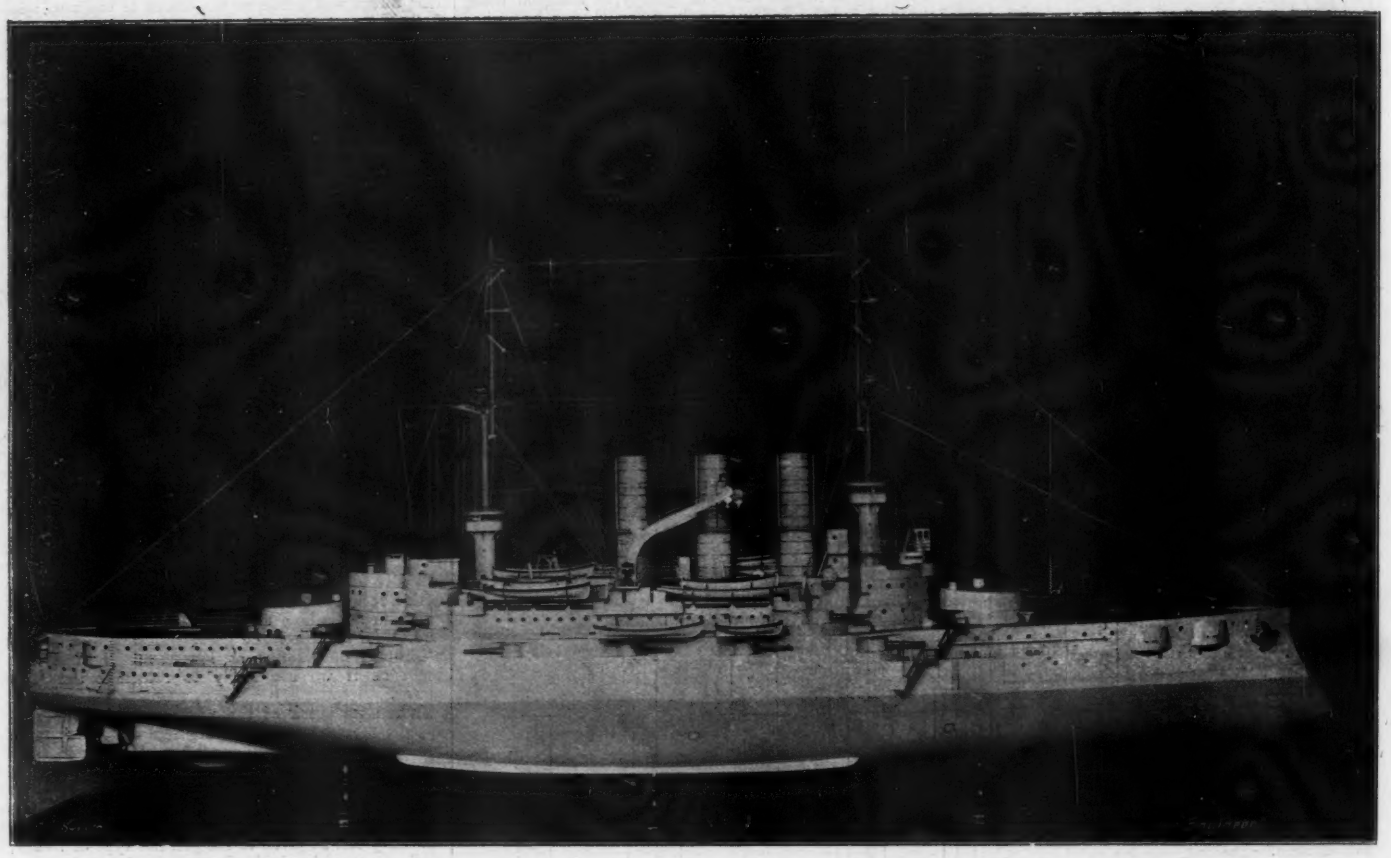
The dimensions of the cylinders remain practically the same as they were a year ago. The ratio or bore to stroke is usually as 100 to 120, although there is a good deal of variation in different types. The Renault engine, for instance, having a uniform bore of 100 mm., with a stroke varying from 120 to 140 mm. for different powers. The only difference in bore is in the 14 horse-power engines, of which the dimensions are 90 by 120. The Renault practice is entirely opposed to the old theory of the "square" engine, in which the bore and the stroke are the same. This theory has still plenty of partisans, who claim that a high angular velocity is favourable to lightness in construction, and there is evidence that several makers are tending to shorter stroke engines. The situation may be summed up in the fact that makers put engines of high angular velocity on their racing machines, and fit their touring cars with engines running normally at from 900 to 1250 revolutions a minute. Most of the vehicles taking part in the Gordon Bennett race had engines running at a much higher angular speed than the motors in the pleasure cars built by the same firms. Chenard-Walcker build their motors with an unusually long stroke, but for racing purposes they are turning out an engine with a bore of 150 mm. and a stroke of 105 mm., the cylinders forming a thin shell, so that this 80 horse-power engine will not weigh more than the ordinary 18 horse-power motor. Such engines are not, of course, intended to last more than for a single race. The motor with a ratio of something like 100 to 120 has obviously so great an advantage as regards economy and durability, and, so far as experience goes, flexibility due to a better utilisation of calories at low speeds, that it does not seem as if we are likely to return to the "square" motor.

When we speak of the utilisation of calories at low speeds, we refer to the only real progress that has been made in the internal combustion engine. The admission of gas of a constant quality at all speeds is obtained by a variety of carburetting devices, but whether any of them are altogether perfect may be open to question. Makers, however, are striving to perfect the only way by which elasticity can be given to the present type of motor, and while it may be doubted whether the explosion motor will ever be given a constant torque at all speeds, it is, at all events, satisfactory that the engine will run silently and can be throttled down to less than 100 revolutions. Most of the developments are in the direction of increased convenience rather than of actual improvement. It is doubtful whether more calories are transformed into actual work than was the case with the older types of engines. It is estimated that not more than 20 per cent. of the calories are thus utilised, the remainder being carried away equally by the exhaust and the cooling of the cylinders. A higher efficiency would doubtless be obtained if makers did not feel themselves called upon to provide the most effective means of radiating heat. If the engine could run at the highest possible temperature without burning the lubricating oil, it would give better results; but, for the sake of simplifying the cooling arrangement, and avoiding the necessity of carrying a large water tank, or frequently renewing supplies, manufacturers prefer an active water circulation through a radiator offering the greatest possible cooling surface. Seeing that the owner wants a car that will give him the least possible trouble, it is perhaps only logical that the cellular tank should have come so much into vogue, although it is in a fair way of being replaced by the ingenious multitubular radiators, which are claimed to give a higher cooling efficiency than the honeycomb type, without its inconveniences. This excessive cooling, while regarded as necessary for the general body of users, who can hardly be expected to pay proper attention to their motors, is calculated to reduce the engine efficiency, and is one of the reasons why there is a tendency to increase the powers of motors on touring cars. The most rational system of cooling is the circulation of water upon the thermo-syphon principle, employed on the Renault and Richard-Brasier cars; but, for the sake of convenience, it has been found necessary to economise the water supply by fitting large radiators, with forced air circulation. One of the advantages of the thermo-syphon radiator is that it dispenses with the pump, which was at one time a frequent source of trouble; but pumps, carefully designed, and capable of being easily taken to pieces for inspection or repairs, are now usually driven off the magneto shaft.

As all the timing and other gear is entirely enclosed, makers have to provide special facilities for dismantling, and one of the features of the engines at the Paris Show is the accessibility of the valves, cam shafts, and ignition gear. This is particularly noticeable in the engines of the Compagnie de l'Industrie Electrique et Mécanique, of Geneva, where the valve stems and cam shafts can be removed and replaced in a very few minutes. It is evident that this accessibility is becoming an important feature in motor construction. It also tends to the standardising of engines, and every maker now lays himself out to supply motor parts. The motors are almost invariably throttled by a butterfly valve in the induction pipe, but the Decauville Company throttles by a sleeve moving vertically just under the inlet valve, so that there is a variable annular aperture around the valve. It is becoming less and less the practice to give a variable lift to the induction valves, although in the Delaunay-Belleville engine both the inlet and exhaust valves are given a variable lift, at the same time that there is a special type of throttle to prevent any possibility of the gases firing back into the carburetter. Such high-class

MODEL OF GERMAN BATTLESHIP DEUTSCHLAND

For description see page 619)



firms as Darriquand and Marre are turning out engines for motor cars, and this construction of motors in considerable numbers by firms specially equipped for the work promises to become one of the most interesting developments of the automobile industry.

The show this year differs from previous ones in the sense that there is far less variety in the types of motors exhibited. As a rule, the two-cycle motors do not offer much of special interest. There is, however, something distinctly novel in the two-cycle engine exhibited by M. René Legros, of Fécamp—see Fig. 1. Instead of the gases being compressed in the crank case or in a separate cylinder, this is done between two pistons, one of which is fixed. The fixed piston is carried on a hollow vertical arm communicating with the carburetter. It is covered by a moving piston, with the crosshead just clear of the under part of the fixed piston when the former is at the limit of its upward travel. On the upward stroke the fresh gases are drawn through the hollow arm up over the fixed piston, and are prevented from returning by a stop valve in the carburetter. On the downward stroke the gases are compressed in the space between the two pistons. A pipe from the chamber at the bottom of the hollow arm communicates with the induction valve at the top of the cylinder, loaded to admit the gas at a certain pressure. At the moment when the piston has descended, and uncovered two large exhaust ports, the induction valve opens, and the fresh charge drives out the remaining burnt gas. Seeing that there is an appreciable lapse of time between the explosion and the admission of the fresh charge, there is no danger of premature ignition, but the temperature is, nevertheless, raised sufficiently to ensure a rapid and thorough combustion. Another novel engine is the rotary motor of M. Maillard, which recalls memories of many another invention of a similar kind in the early days of the automobile industry. The rotary engine appeared to have died out, when it was resuscitated by the one at the Paris Show. It is composed of a disc with a circular cylinder on its periphery. In this cylinder are four pistons, forming segments of a circle. Each piston-rod hinges at an angle on a short arm from the shaft rotating with the engine. Working on the four-cycle system, the motor has four induction valves and four sparking plugs. The explosions take place successively between the pistons, which are driven apart, the forward piston giving a positive drive to the shaft through the rod on the fixed arm, while the backward motion of the second piston is transformed into a forward drive by the reversal of the angle forming part of the articulated lever. Running at 900 revolutions, the engine develops 5 horse-power, and the weight is 70 lb. The double-acting engine has also claimed attention, and such a one is the Cote motor, in which a long trunk piston runs in a single cylinder having slots for the passage of a crosshead, the rods connecting with the crank shaft underneath. The only other engine in the show possessing special characteristics is the motor of the Vagenfabriks-Aktiebolaget of Södertelge, Sweden, in which the compression is kept constant by a variable admission of air that is isolated, as it were, from the incoming charge. This motor was illustrated and described in our report of the Paris Show last year. Since then tests have been carried out in Sweden showing that the consumption varies with the load, without any appreciable variation of speed, from 1·338 kilos. of petrol under light load to 2·79 kilos. under full load in a motor with a bore and stroke of 120 mm., and running at from 640 to 655 revolutions a minute. In ordinary petrol motors, with necessarily varying compressions, there is no such relative economy of consumption under light loads.

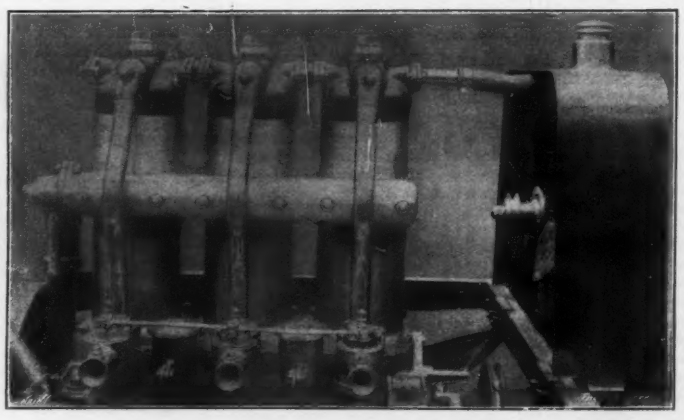


Fig. 1—THE LEGROS ENGINE

The use of paraffin, alcohol, and other "safe" fuels has not been making much headway. Plenty of theories have been put forward to prove that the heavier oils and alcohol are more suitable for internal combustion engines than petrol, and there is no doubt that the petroleum engine is destined, at some time or another, to replace the spirit motor. But despite its undoubted advantages the paraffin engine has not been able to overcome the insuperable drawback, from the automobile manufacturer's point of view, of not being easily started when cold. The carburetter must be warmed with a plumber's lamp, or the engine must be started with petrol and then turned on to paraffin. Besides, it cannot be said that any of the paraffin carburetters now on the market give entire satisfaction, although one or two of them certainly give promising results. It is probable that the indifferent performance of paraffin is due less to the carburetter than to the engine itself. We have before pointed out that there is a distinct difference between the action of the petrol motor and the paraffin engine, for while one is a purely explosion motor the other may be regarded as a rapid combustion engine, which depends for its successful working upon the total burning up of the by-products. So long as it was left to automobile builders to decide whether or not petrol should be replaced by paraffin, this latter can hardly be said to have been given a fair chance, for the motor car maker would have nothing to do with paraffin when he found that it would necessitate slightly heavier engines and would become intolerable in the event of a defective mixture, resulting in a black and evil-smelling exhaust. If the motor car maker can do without the paraffin engine, the same thing cannot be said of the builder of motor boats. This latest development of the automobile industry has been one of the most remarkable features of the past year. The display of motor boats in the Horticultural Palace annexe is a large one, and there is no doubt that the building of craft propelled by internal combustion engines will grow enormously in the future, if only it be found possible to obtain suitable paraffin motors. This is the only thing that is standing in the way of a more active expansion of the industry. The paraffin engine is therefore being seriously taken in hand by engineers, one of whom, M. Turgan, is exhibiting at the

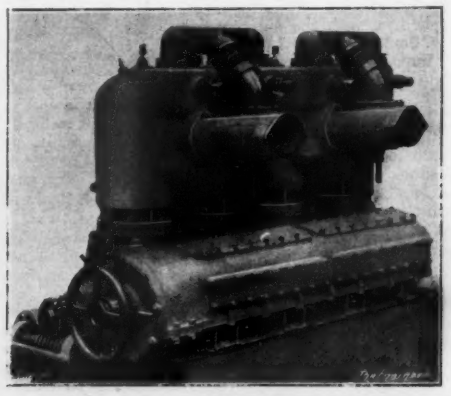


Fig. 2—THE TURGAN MARINE MOTOR

LAUNCH OF THE GERMAN BATTLESHIP DEUTSCHLAND

HERR FRIED KRUPP, KIEL, BUILDER

Paris Show a paraffin marine motor developing about 150 horse-power at 550 revolutions a minute—see Fig. 2. It has a bore of 200 mm. and a stroke of 250 mm. The weight of this engine is nearly a ton. There is a separate carburetter for each pair of cylinders. It is placed inside the exhaust pipe, and the oil is sprayed by a pump. The engine is started by an electric motor through worm gearing, this motor, of course, subsequently re-charging a small battery employed for the purpose. The engine is reversed by altering the position of the cam shaft.

After all the inducements that have been held out by the French Government to develop the alcohol engine it is a little disappointing to find that absolutely nothing further has been done with the agricultural spirit. Races have been held, shows organised, and special prizes offered as an encouragement to engineers to design carburetters and engines capable of running successfully and economically with alcohol. The result of four years' effort is that there is not a single alcohol engine in the Paris Show. The interest in alcohol has entirely died out. It is true that makers of paraffin carburetters claim that they are equally suitable for alcohol, but while the carburetter is the vital part of the motor the design of the engine also accounts for a great deal in the proper utilisation of alcohol, and there is little encouragement to build alcohol engines when the cost of the spirit is about the same as petrol and is appreciably higher than the cost of paraffin, which is a much more satisfactory fuel.

THE GERMAN BATTLESHIP DEUTSCHLAND.

On November 25th we described in some detail the most recent addition to the German navy. By the courtesy of Messrs. Krupp, her builders, we are now enabled to illustrate the ship by an engraving from a photograph taken from a scale model, and as she was launched, and, for the convenience of our readers we reproduce her principal dimensions.

She was built on one of the covered slips of the Germaniawerft, and her principal dimensions are the same as those of the Braunschweig class, of which this vessel herself, only recently put into commission, and also the Hessen, approaching completion, were likewise built at the Germaniawerft.

Length between perpendiculars	121·5 m.
Maximum breadth	22·2 m.
Draught	7·65 m.
Displacement	13,200 tons

Armour.—The belt has 225 mm. thickness amidships and 100 mm. at the ends. The armoured deck extends from fore to aft, its sides slope and join the lower edge of the belt. There is, besides citadel armour, a battery deck casemate covered in by a protective deck. To protect the commander and the commanding organs there are two conning towers, fore and aft, of 300 mm. and 140 mm. respectively.

Armament—

Four 28 cm. guns in 280 mm. turrets fore and aft.
Ten 17 cm. guns in the central casemate.
Four 17 cm. guns in separate casemates.
Twenty-two 8·8 cm. guns.
Four 3·7 cm. automatic guns in the fighting tops.
Four 8 mm. machine guns.
Six submerged torpedo tubes.

The propelling machinery of the new ship consists of three triple-expansion engines, intended to indicate 16,000 horse-power and to give a speed of 18 knots. The steam generating plant, comprising six cylindrical and eight water-tube boilers, on the Schulz-Thornycroft system.

The coal capacity is normally 700 tons; by filling the reserve bunkers, however, it may be raised to 1600 tons. The double-bottom compartments are fitted to carry 200 tons of tar oil, likewise available for fuel.

The vessel is intended to be a flagship, and provides quarters for a staff of 35 officers and 35 warrant officers, 16 ensigns, and 656 men.

THE USE OF INDIA-RUBBER GLOVES.

In a case which came before Mr. Justice Darling at the Leeds Assizes on December 8th, a point arose which is of some interest to those who employ workmen who are exposed to the risk of electric shock from naked conductors. It appeared that the plaintiff was employed to paint certain electric tramway standards near Dewsbury. Owing to the fact that trams were running, the usual form of insulated derrick could not be used, and the plaintiff was compelled to reach the upper part of the standard by a ladder. While painting the bracket he accidentally touched the live wire, with the result that he received a severe shock. This caused him to fall to the ground. Both his arms were broken. He then brought an action against his employer, a journeyman painter, alleging that he had not been warned of the danger. He also alleged that if the defendant had taken the precaution of supplying gloves made of india-rubber, the accident could not have happened. The defendant asserted that he had warned the plaintiff not to touch the live wire. He also alleged that he had himself painted over 1000 standards, and had never had an accident. With regard to india-rubber gloves, he had heard of such things, but did not think it necessary to supply them.

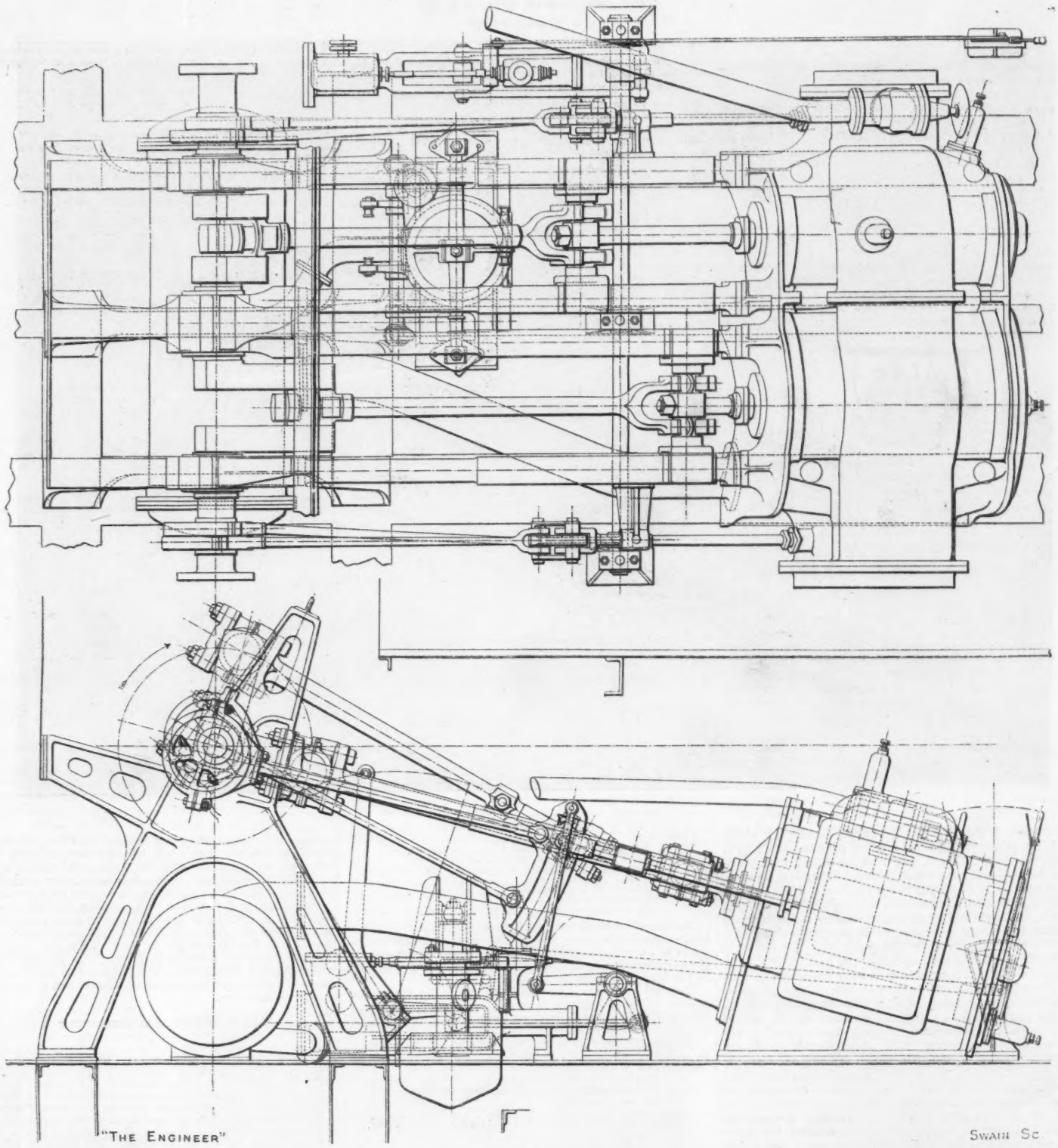
In summing up to the jury, the learned judge said that in considering whether the defendant had not supplied his workmen with proper appliances, regard must be had to the state of knowledge amongst persons of his class. "It may well be," he continued, "that the President of the Royal Society would look upon india-rubber gloves as a necessary precaution; it does not follow that the defendant must do so." His lordship also pointed out that ten years hence the use of india-rubber gloves might have become so general that it would be clearly negligence for an employer not to provide them.

In the event the jury found that the defendant was guilty of negligence, but that the plaintiff was guilty of contributory negligence. This resulted in a judgment for the defendant. It will be noticed that upon the question whether the defendant was negligent, the jury seemed to take a view favourable to the plaintiff. In other words, they seemed to think that india-rubber gloves ought to have been provided. While we may not agree with such a finding, the point is one which may be decided in the same way by other juries hereafter. Those who employ workmen in the neighbourhood of switchboards may be well advised to take the precaution of having india-rubber gloves ready for use. In the case under review, proof of the fact that the defendant had supplied this means of protection would apparently have been a complete answer to the action.

Bradford Engineering Society.—On Wednesday evening last week, at the City of Bradford Technical College, a paper was given by Mr. Edwin Kenyon on "The Transmission of Power by Ropes." After comparing the driving arrangements of Boulton and Watt in the early days of the steam engine with the rope drive of modern times, he discussed briefly the system of electrical transmission, and then proceeded to the subject of the frictional losses in spur gearing, and its liability to breakdown. The efficiency, relative cost, and durability of belt driving having been touched upon, he entered into a full description of the general system of rope driving, and its applicability to the awkward conditions which sometimes obtain in factories, viz., shafts at right angles, driving round corners, shafts out of parallel, vertical drives, &c. The relative merits of manilla, Egyptian cotton, and American cotton, for ropes, with the methods of manufacture, were next given, and an interesting table was shown of the powers which ropes of various sizes would transmit at different velocities. The lecture was illustrated by about 100 slides, and a good discussion followed, in which the President—Professor G. F. Charnock—Messrs. Wilson, Hiles Wigglesworth, and Carter joined.

Glasgow Technical College Scientific Society. — The thirteenth annual dinner of this Society was held in the Grosvenor Restaurant, Glasgow, on the 17th inst., under the presidency of Mr. R. D. Munro, M.I. Mech. E. About eighty gentlemen were present, including Professor Watkinson, of the Technical College; Mr. Charles Day, general manager of Mirlees, Watson and Co.; Mr. A. G. Strathearn, Mr. Frank B. Lee, &c. In proposing the toast of "The Technical College," Mr. Day spoke of technical education for engineers, and remarked that many young men left a technical college with the belief that they were engineers or chemists, and if they had had a successful college career they expected that comparatively uneducated men engaged in the same trade should bow down to them. Fortunately, it did not take very long to disillusionise them in that respect, and when they were disillusionised they soon became useful. Contrasting the systems of technical education in Germany and Great Britain, Mr. Day said time alone could prove which was the more effective, but he inclined to the opinion that the British methods were superior. In Germany there were no evening classes, but he believed that the evening classes had done more for Great Britain than the day classes had done for Germany. The latter were very expensive, and it was only the sons of at least moderately well-to-do people who could afford to attend them. The bulk of the working men in Germany were not technically educated; there was a far larger proportion of men in Great Britain who had received at least a fair technical education.

COMPOUND ENGINES, L.C.C. THAMES STEAMERS



THE ENGINES OF THE NEW PASSENGER STEAMERS FOR THE THAMES.

As promised in our issue of December 2nd, we are now enabled, by the courtesy of the Thames Ironworks Company, to give illustrations, consisting of a plan and side elevation, of the engines to be fitted in the new steamers intended for the passenger service on the river Thames, between Greenwich and Hammersmith.

Premising that these vessels are to be 130ft. long, 16ft. 6in. beam, and 2ft. 10in. draught when loaded, and their intended working speed at that draught 12 statute miles per hour, the motive power to attain that speed in regular service is to be obtained in each vessel by an engine—as shown in our illustration—of the diagonal two-cylinder compound type, driving a pair of paddle-wheels, 10ft. 6in. diameter over the floats; the cylinders being 16in. and 31in. diameter by 2ft. 6in. stroke; the working pressure is to be 115 lb.; and the engines, when running at a speed of 55 revolutions a minute, are expected to develop 270 indicated horse-power.

The engine, it will be seen, consists of three A-shaped cast iron frames carrying the main crankshaft bearings, the frames being securely bolted at their feet to seatings worked up from the vessel's frames, and at their heads to the sponson beams as usual. The cylinders are placed as shown, in an inclined position forward of the paddle shaft, the high-pressure being on the port side of the vessel; the piston-rod guide bars, which are of forged steel, on both cylinders forming the connections between them and the main bearing frames. The main crank shaft is of wrought steel 6¾in. diameter, forged in one piece, having a coupling flange at each end as shown for connecting up to the paddle-wheel shafts, which are also of steel.

The surface condenser, which is cylindrical in form and of light construction, is placed athwartships as shown, between the legs of the main bearing frames, its shell being built of Muntz metal plates riveted together and joints sweated, and its water ends of copper; the tubes, which are of brass, will be fitted into the tube plates with screwed glands and tape packing. The cooling water is supplied by an independent centrifugal circulating pump, a small auxiliary air pump being driven off the same engine. The main air pump, which is of the Edwards type, and which will be seen in the plan and side elevation, is placed aft of but on the centre line of the high-pressure cylinder, is driven by link and lever gear off the high-pressure connecting-rod, the feed and bilge pumps being also actuated by the same gear. The paddle-wheels, which are of the feathering type, have arms and rims of wrought iron, the wheel bosses being of cast steel, secured to the paddle shafts by steel pins. The floats are of American elm, the working pins of steel cased with gun-metal, and the arm bosses and radius rods bushed with lignum vitæ.

Steam is supplied by an ordinary marine cylindrical boiler of the return-tube type, 9ft. diameter by 8ft. 9in. long, having 700 square feet of heating surface and 25 square feet of fire-grate area; Howden's system of forced draught being applied, with a special spark arrester uptake. An independent fan and engine are placed in the stokehold for the supply of air to the furnaces through the Howden apparatus, which delivers it to the fires considerably raised in temperature. For the ready handling of the main engine a Brown's steam starting engine is fitted—seen in illustration on the port side of the plan—having a by-pass valve to the low-pressure cylinder receiver. A silent blow-off to the condenser is also fitted to carry off any steam that may have accumulated during brief stoppages at the river piers. The engine-room equipment also includes a steam steering engine, an electric light engine and dynamo, an auxiliary feed engine, and a large reserve feed-water tank. Of the service in the near future intended to be performed by the new passenger Thames river steamers, under the ægis of the London County Council, we may have something to record in a later issue.

The Leeds University Engineering Society.—At the last meeting of this society, Mr. C. E. Stromeyer, in a highly technical paper, discussed "The Difficulty of Attaining Maximum Efficiency of Boilers without Injuring Them." He remarked it was easy to state the problem in its simplest form, but it grew more and more difficult when practical experiences are called in for assistance. When complete combustion is obtained with only a requisite air admission, the heat of the boiler furnace is sufficient to melt osmium, and with twice that quantity of air a temperature of 2527 deg. Fah. is obtained. These high temperatures are reduced in practice by using about twice the theoretical amount of air, which is heated initially before entering the furnace. This expedient is not available for marine boilers, and the British Admiralty have adopted a modification of the Belleville boiler, in which the flames, after passing one nest of tubes and being thereby killed, are admitted to a second combustion chamber, and then pass through a second nest of tubes. The lecturer examined the question of the effects of high temperatures on boiler working, the leakage of water tubes, and the distortion of tubes and plates. In conclusion, he said it is highly desirable to ascertain if boiler troubles and mishaps are inseparably associated with high furnace temperatures due to minimum air admission, or whether these bad effects are due to sediment, grease, scale, &c. He suggested that possibly some impurity could be added to the water so as to give a stronger cooling effect on the boiler plates than at present. A discussion followed the lecture, and Mr. Stromeyer was accorded a hearty vote of thanks.

RAILWAY MATTERS.

AN extension of the Colchester Corporation tramways, estimated to cost about £8000, has been decided upon.

THE traffic receipts of the Geneva Tramways Company for the month of November, 1904, were 168,358f., an increase on 1903 of 14,470f.

THE work of constructing a railway on the Ivory Coast between Petit Bassam and Eryma Koulie, a distance of 110 miles, is now in hand, and is expected to be completed in two years.

THERE is only one railway bridge in Ceylon with spans of 150ft., and that is over the Kala Oya, the boundary between the North-Western and the North-Central Provinces. It has, however, only two spans of 150ft.

FOR the purpose of facilitating the transport of freight between the various railway stations of the capital, the Russian Ministry of Ways of Communication has decided to order a number of automobiles for the use of the State railways having termini in St. Petersburg.

THE collective length of line in the seven large French railway systems—the Nord, Est, Ouest, Orleans, P.L.M., Midi, and Etat—has increased in nineteen years by 9347 kiloms. = 5808 miles, viz., from 27,959 kiloms. = 17,373 miles in 1884 to 37,306 kiloms. = 23,181 miles in 1903.

THE New York Subway finished its first month of operation on November 26th, having carried about 6,000,000 passengers. The daily average of traffic, not counting the Lenox-avenue branch, which opened only a few days ago, was 201,318, showing daily average receipts of £2013.

THE Russian South-Eastern Railways have decided to order 1000 goods wagons and fifteen locomotives. Russian trade generally is suffering greatly from the lack of trucks, as so many have been sent out with freight for the troops in the Far East. The sugar industry is suffering especially in this respect.

THE directors of the Midland Railway have appointed Mr. Henry Evans, goods manager of the Glasgow and South-Western Railway, to succeed Mr. W. E. Adie as goods manager of the Midland from March 1st next. Mr. Eaton, superintendent of the Midland Railway line, who has been with the company nearly forty-three years, has resigned.

THE decision of the directors of the Great Northern Railway Company to invite locomotive builders to construct engines for trial on the Great Northern lines is being given effect. A contract has been placed with the Vulcan Foundry, Limited, of Newton-le-Willows, for a large express engine of the four-cylinder compound type, and it will be completed in time for experimental purposes next summer.

THE Streets Committee of the City of London Corporation have decided to adjourn until the New Year the further consideration of the application of the London County Council for sanction to their proposal for connecting the present tramway termini in Blackfriars-road and Westminster Bridge-road by the construction of double-track tramways over Blackfriars and Westminster Bridges and along the Victoria Embankment.

ACCORDING to the report of the Barsi Light Railway for the year, the number of passengers was 73,104, and of goods 57,562 tons. As compared with last year, there is an increase of 23,018 tons and Rs. 50,810 in goods traffic, and of Rs. 4581 in passenger traffic and sundry receipts, a total increase of Rs. 55,392, while the increase in working expenses amounts to Rs. 14,538. The percentage of working expenses on gross receipts was 55·85 against 71·05 for the previous year.

AN important arrangement has been arrived at between the London and South-Western and the Great Western Railway companies. On and after January 1st, ordinary and tourist tickets issued for Exeter, Plymouth, and Devonport at Waterloo and Paddington will be available for return by either the London and South-Western or the Great Western route. A similar concession is made for the return journey on ordinary tickets issued at Devonport, Plymouth, and Exeter, for Waterloo and Paddington.

DURING the past year a quarter of a million parcels were carried on the Bradford trams. It is hoped that by the new year a scheme will be in operation which will enable the tramways committee to cope with a very much larger number. The cars will not be the only vehicles used for the collection and delivery of the parcels, but full advantage is to be taken of the adaptation of the petrol motor to this class of work. Three capacious vans will cope with all the traffic within a radius of half a mile from the Town Hall.

THE Correctional Tribunal delivered judgment on Saturday in the case arising from the disaster which occurred at the Couronnes station of the Paris Metropolitan Railway in August, 1903. The guard of the train and the station-master were each sentenced to a month's imprisonment under the First Offenders Act, and directed to pay 2000f. damages, while the motorman was ordered to pay a fine of 3000f., and another guard one of 2000f. The railway company is declared to be liable with regard to the claims arising out of the case.

IN Chicago, recently, there has been considerable agitation concerning the noise made by the elevated railway trains in passing over the loop terminal line in the downtown business district. A public inquiry upon the matter was recently held, and a plan for reducing the noise was submitted by Mr. J. B. Strauss, consulting engineer. This plan was substantially to encase the steel structure in concrete, and to lay the rails on longitudinal timbers in concrete troughs, with a cushion of sand or asphalt between the timber and the concrete.

IT has been proved on the Danish State Railways that when a given type of locomotive, which can run up to 24,850 miles on a given track without having the wheels turned up again, was run on a lighter track, it could hardly do 18,640 miles. Conversely locomotives which run on a stiffer track give a better mileage. It was all the easier to investigate this point on the Danish State Railways, as there are different lines with rails weighing 44·3 lb., 63·5 lb., and 75·6 lb. per yard respectively, and locomotives with wheel loads of 3·9, 4·9, and 6·4 English tons.

THE locomotive testing plant established and operated by the Pennsylvania railroad system in the Transportation Building at the World's Fair made a remarkable record on Thanksgiving Day. Three tests were conducted which were the most satisfactory of any which have yet been made. The locomotive under test was the Cole four-cylinder balanced compound. The first test was run continuously for two hours at a speed of 57 miles per hour. The second test continued for an hour and a half at a speed of 66 miles per hour. The third test was for a full hour at the remarkable speed of 75 miles.

THE number of women employed on the Russian railways is increasing. According to the latest official returns there are now working on the twenty-five Russian State Railways no less than 22,000 women as gatekeepers, clerks, telegraphists, &c. The average wage varies from 130 to 135 roubles yearly, or from £13 16s. 3d. to £14 6s. 10½d. The extremes are very great. Thus, the women clerks receive on an average from 450 roubles to 460 roubles, or about £48, while the women attendants at the stations are paid only 40 roubles, or £4 5s. a year, in addition to free lodging and a few extras.

NOTES AND MEMORANDA.

THE dead-weight of live people in dense crowds may go up to above 150 lb. per square foot of floor area, or will equal 29in. of water.

AN 8ft. steel chimney, 230ft. in height, has just been completed and will be erected in Mexico. This will be the highest steel chimney in America.

TO prevent corrosion of copper pipes by contact with sea water the addition of 0·5 per cent. arsenic is recommended. Phosphorus in iron acts similarly.

FRANCE exported automobiles to the value of 49,476,000f. = £1,979,040 during the first eight months of the present year, against 36,476,000f. and 19,891,000f. during the corresponding periods of 1903 and 1902 respectively, while her imports of motor cars were insignificant.

THE largest ferryboats in the United States are those which ply between Oakland and San Francisco. The first of these was built in 1898. She is propelled by triple-expansion engines, is 284ft. long, 64ft. beam, 17ft. depth of hold, 1945 gross tons displacement, and has seating accommodation for 1700 persons. She has a dining-room and other similar accommodation.

DURING November Scotch shipbuilders launched 24 vessels, of about 28,270 tons gross, as compared with 27 vessels, of 43,495 tons gross, in October, and 21 vessels, of 29,219 tons gross, in November last year. In the eleven months Scotch builders have launched 293 vessels, of 388,674 tons gross, as compared with 266 vessels, of 406,292 tons gross, in the corresponding period of last year.

ACCORDING to Sir James Dewar, by utilising wood charcoal at a low temperature as a gas absorber, and cooling a tube of helium by means of liquid hydrogen, it has been shown that the boiling point of helium must be about 6 deg. absolute temperature. The existence of very small quantities of helium has been proved in the gases in solution in rain water, in sea water, and even in the water of the Thames.

A DAM is being built at Lake Cheesman in connection with the water supply of Denver. At the bottom the width of the cañon across which it is built is only 30ft.; at the level of the road over it is 710ft.; the bottom thickness of the dam is 176ft., while at the top it is 18ft. thick. The height at the centre is 227ft., and the upstream face is curved to a radius of 400ft. It is built of granite set in Portland cement mortar.

THE prize of 50,000f. = £2000, founded by Henry Deutsch and Ernest Archdeacon, will be awarded to the owner of the first aërial appliance, without balloon, that accomplishes the distance of a kilometre, or about five-eighths of a mile, without touching earth, in presence of the committee appointed by the Aëro Club of France, from the secretary of which, 84, Faubourg Saint-Honoré, Paris, the conditions may be obtained.

ENGLISH shipbuilders in November put into the water 30 steamers, of about 70,064 tons gross, against 25 vessels, of 64,341 tons gross, in October; 25 vessels, of 59,270 tons gross, in November last year; and 25 vessels, of 49,860 tons gross, in November, 1902. During the past eleven months English builders have launched 288 vessels, aggregating about 679,780 tons gross, as compared with 272 vessels, of about 562,851 tons gross.

THE fire loss of the United States and Canada for the month of November shows a total of £2,303,000, which is about £400,000 less than the sum chargeable against the same month of last year, but about £200,000 more than the figures of November, 1902. The total fire loss for the eleven months ended November 30th, 1904, is estimated at £46,588,340, as compared with £27,600,000 for the first eleven months of last year, and £26,920,000 for the corresponding period of 1902.

ONE of the most important processes now used for waterproofing dress materials is on the lines of the old alumina process. In this case the factor used is resin, dissolved in a large bulk of petroleum spirit. The fabrics to be proofed are passed through a bath of this solution, and dried to drive off the solvent. Following this, the goods are treated by pressing with hot polished metal rollers. This last process melts the small quantity of resin which is deposited on the cloth and leaves each single fibre with an exceedingly thin film of resin on it.

A SENSITIVE fire-alarm which has been brought out by a Danish inventor, only acts when a sudden wave of heat is generated. A U-tube, 4in. high, is filled with mercury, the upper parts containing sulphuric ether, and both ends being closed. One side of the tube is covered with a non-conducting material. An even and gradual rise of temperature warms the entire apparatus, but a sudden heat, as in fire, vaporises the ether under the unprotected glass, forcing down the mercury, and ringing an electric bell by the closing of a local contact.

BUENOS AYRES, the progressive capital of Argentina, is the most important seat of electrical industries in South America, and has six large railway, lighting, and power companies. The power stations are in the outlying districts of the city, and current is generated and distributed at voltages ranging between 1000 and 6000 volts, which is stepped down for use by means of transformers placed in sub-stations and cellars. The cost of power varies from 1d. to 7d. per kilowatt-hour, depending on the quantity, voltage of supply, and location of the consumer.

IN a paper recently published in the *Revue Technique* M. L. Levi makes the following comparison between the calorific values of different fuels used in internal combustion engines:—British thermal units per pound—Methylated alcohol, 10,620; methylated alcohol mixed with 50 per cent. gasoline, 14,200; crude American oil, 19,630; refined American oil, 19,880. The mixture of methylated alcohol can, it is stated, be used as easily as ordinary gasoline, but with unmixed gasoline it is necessary to warm up the carburetter a little before starting, as the alcohol does not vaporise readily enough below a temperature of 68 deg. Fah.

A REMARKABLE saving in changing a plant from coal-consuming steam engines to oil engines has been experienced by an electric light and power company at Key West. The fuel bill of the company has been reduced from over £4800 per annum to under £1200. The enormous gain from the use of the oil is partially explained by the previous extravagant or wasteful use of the coal. The plant consumed upon an average 5 lb. of coal per kilowatt-hour, and the coal cost 20s. per ton. The water supply was bad, and the maintenance of boilers and condensing apparatus was troublesome and expensive. The oil now used costs 3 cents a gallon, the consumption is ·7 lb. per kilowatt-hour.

A PAPER on the use of dry air in blast furnaces was read recently before the Paris Academy of Sciences, by M. Herin le Chatelier. The economy claimed for the use of dry air is ascribed by the inventor of the process to the fact that the moisture of the undried air transforms a certain proportion of the coke into hydrogen and oxide of carbon. From the figures of the amount of water removed, it is possible to calculate exactly this loss; it is 5 per cent., or only one-fourth of the amount claimed. It is certain, then, either that the economy claimed is incorrect, or else that the true cause is to be sought for elsewhere. The author shows that the quality of the iron produced, especially as regards its sulphur impurity, is an important factor, and that when the sulphur is to be kept down to a certain percentage, the economy of fuel claimed by Gayley may be real.

MISCELLANEA.

GERMAN agricultural implement makers have received lately large orders from Siberia through agents at Warsaw.

THE Russian Ministry of Finance has made a grant of £10,625 towards the cost of building a river harbour at Cherepovetz.

THE Workington Council have applied for an extension of time for carrying out the provisions of their electric lighting order, 1901.

AN inquiry has been held into the application of the Erith Council for sanction to borrow the further sum of £20,000 for the purposes of the electricity undertaking.

GREENWICH footway tunnel was originally estimated to cost £70,500. The actual expenditure upon it to date has been £121,336, and the total estimated outlay is £180,115.

THE erection of a new bridge at a cost of £2000 at Llanfair Caereinion, Montgomeryshire, is to be proceeded with. The county surveyor is preparing the necessary plans and estimates.

NOTWITHSTANDING the depression which until the last few weeks has existed in the Lancashire cotton trade, we learn that a new cotton mill to hold at least 50,000 spindles is to be erected at Heywood.

SATISFACTORY trial surveys have been made, and steps are being taken to raise £3,200,000 for the construction of a line of railway under the Bernese Oberland, which is to join the Simplon Tunnel line.

IT is reported that Sir Theodore Angier has said that plans are ready for a new canal, to be cut through the Isthmus of Suez, parallel with the existing one, which would cost only £6,000,000 to construct.

THE Yarmouth Corporation have decided to grant a rebate of ¼d. per unit on the present charge of 2½d. per unit for the supply of electric energy to the Tramways Committee after a consumption of 100,000 units.

THE United States armoured cruiser Tennessee was launched on December 3rd at the Cramp shipyards, Philadelphia, Pa. She is of 14,500 tons displacement, and will be one of two of the most powerful cruisers in the American navy.

SURVEYS and estimates relating to the cutting of a canal on the Ivory Coast between the Comoe River and Assinie have already been made, and a concession to a private syndicate for this work has been granted by the Government.

IT is understood that orders are about to be issued from the War-office for the expenditure of two and a-half millions sterling in connection with the re-armament of the Royal Horse and Royal Field Artillery at home and abroad. It is stated that the work will be divided between Woolwich Arsenal, Sir William Armstrong and Co., Elswick, Vickers, Sons and Maxim, Erith, and Cammell and Co.

THE development of the gold mines on the Ivory Coast is being pushed forward, and the engineers are unanimously of opinion that this colony is a rich mineral country. In the eastern portion of the colony the most extensive works are being carried on, namely, in the Sanwi and Indenie districts. Shafts to the depth of 100ft. have already been sunk, and great hopes of a crushing mill are entertained for one of the properties for next season.

IN the latest and most economical way of gathering rubber in New Guinea the natives tap the rubber trees and smear the gum in layers over their bodies. The heat of their bodies and the sun dry the solution up, when "they march off like mechanical rubber dolls to the dealers, where they are stripped and released, to gather more of the valuable gum." An india-rubber credulity is suggested as a necessity in reading this item of news.

THE Admiralty have placed orders with Vickers, Sons and Maxim for ten additional submarines of B1 class, one of which recently went through highly successful evolutions in deep water outside Barrow harbour. The new submarines embrace all improvements suggested by Admiralty officials from the information gained in trials and experiments made with the existing submarine flotilla. The new class of submarines are considered by far the best of any yet built by any Power.

AN explosion occurred early on Saturday morning at the Ebbw Vale Iron and Steel Works, the result of the molten metal in the No. 2 blast furnace breaking through the bottom of the furnace and reaching the water culverts beneath. The shock of the explosion was felt in the town, and many windows were broken in the surrounding district. Many of the adjacent buildings belonging to the works were damaged. It is remarkable that, although workmen were near the furnace at the time of the explosion, no one was injured.

THE machinery trade of Cuba is almost entirely controlled by the United States, which furnishes 75 per cent. of the total imports, the United Kingdom following with 14 per cent., and the remainder being divided between Belgium, Germany, and France. The imports of British machinery are nearly double what they were in 1902, but they are restricted to a very few items. The United Kingdom supplies 17 per cent. of the sugar-making plant. In electrical machinery, pumps, boilers, and locomotives, British manufactures are scarcely represented at all.

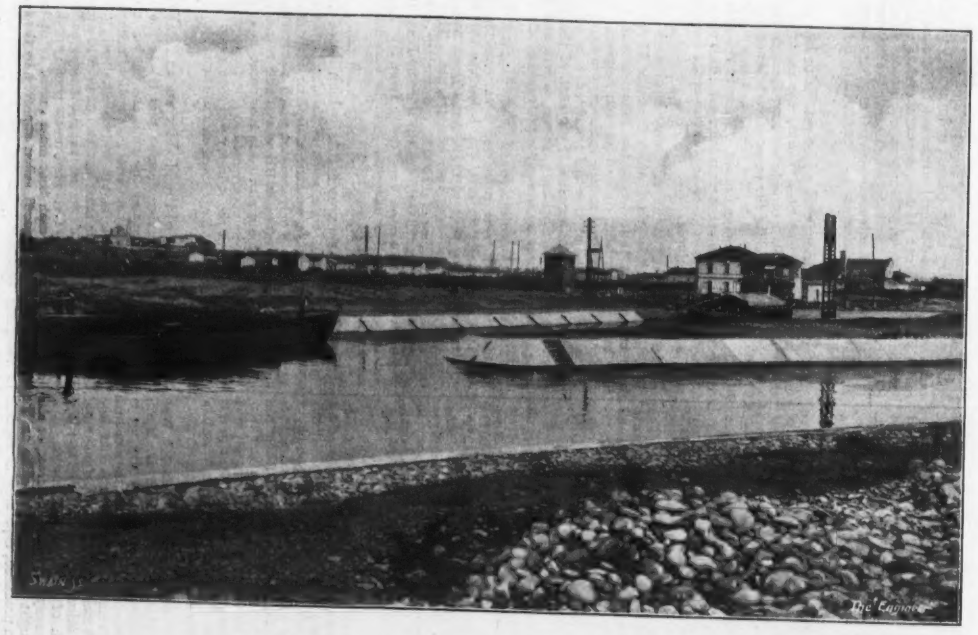
THE Works Committee of the Mersey Docks and Harbour Board last week submitted a recommendation to spend £41,000 in deepening to 19ft. 6in. below the old dock sill the greater part of the body of the Queen's Dock, with the view of bringing the branch dock into effective use. They also recommend the expenditure of £7300 in constructing a roadway and laying down railway lines from the Hornby Dock to a gateway which gives access to the dock estate from Fort-road, Seaforth. The proposal, which is unopposed, will be considered at the next meeting.

THE numerous experiments which have been made down to the present time, some of them on quite an extensive scale, have clearly shown that a superior class of cotton can be raised in Cuba. The only question which remains to be decided is whether there is sufficient labour available at reasonable prices for picking the cotton if planted in considerable quantity. Should no serious difficulty be experienced in this direction, there is every reason to expect that the industry will soon come to be of great importance, and that large shipments will be made to the United Kingdom.

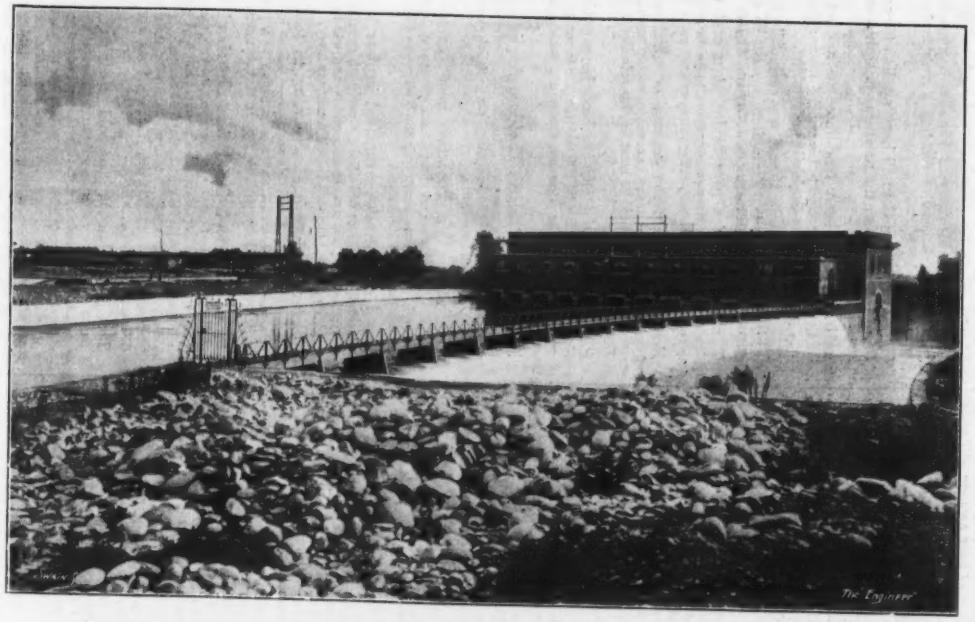
THE Committee of the Mediterranean Challenge Cup for motor boats has further decided that (1) as the boats will be decked, the dimensions of the hulls and the power of the motors is not limited; (2) only internal combustion, instantaneous steam generation, or electric motors will be admitted; (3) the speed at trials in calm weather must not be less than 12 nautical miles per hour; (4) renewal of the oil supply, except at the regulation points of touching, is forbidden under penalty of disqualification; and (5) the crew of each boat must consist of at least five men, including an experienced sailor, approved by the committee, and a sea-going engineer. Besides the Mediterranean Cup for the boat that makes the distance between Algiers and Toulon, *viâ* Mahon, in the shortest time, special prizes and certificates will be granted for various qualities.

THE HYDRO-ELECTRIC POWER STATION AT TURBIGO, ITALY

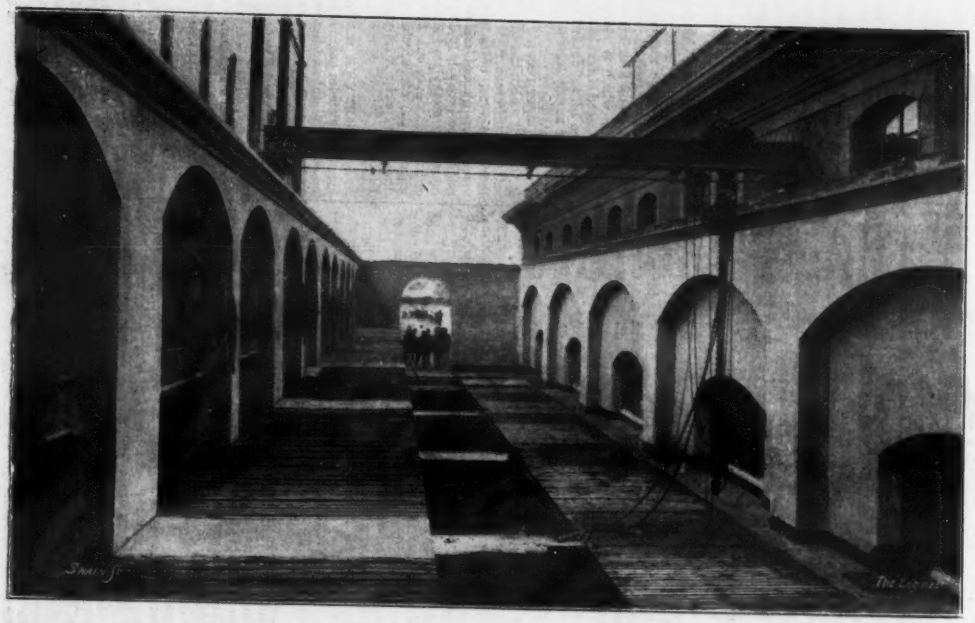
(For description see page 628)



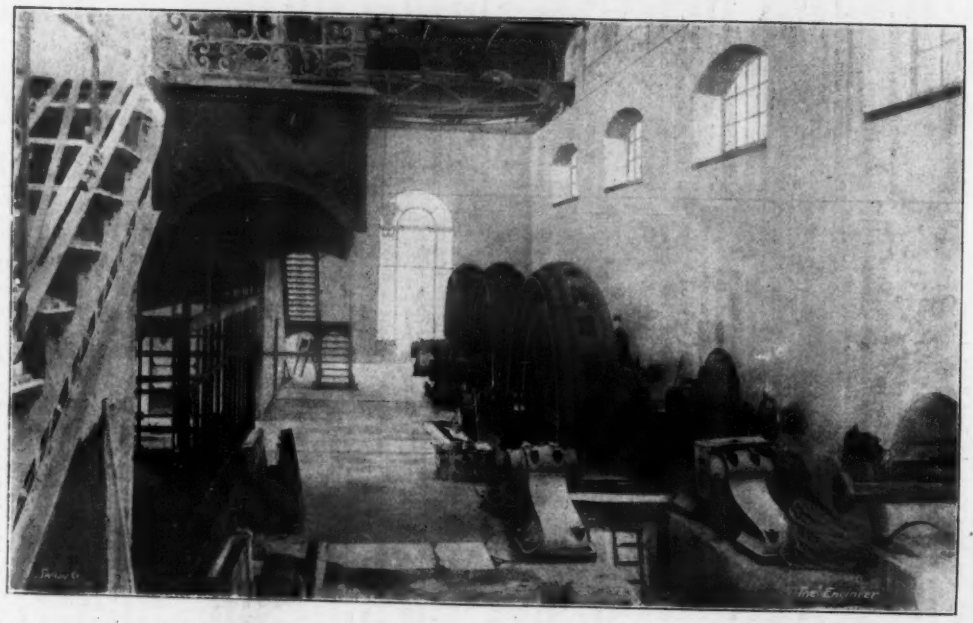
BIFURCATION OF CANAL ABOVE POWER STATION



POWER STATION



SLUICE VALVE GALLERY



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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

G. N. E. (Dundalk).—There is, we believe, no entrance examination. Write to the secretary, 11, Victoria-street, Westminster.

ONE INTERESTED.—Your letter is published on another page, and is commented on in a sub-leader below. The subject will bear discussion. It is difficult to account for the facts.

TRANSIT.—(1) We should recommend you to apply in the first instance to Mr. A. J. Cotterill, Engineer-in-chief of Ways and Works, Egyptian State Railways, Cairo. (2) Write to Mr. J. J. H. Teall, F.R.S., Director of the Geological Survey, Jermyn-street, S.W.

OLD CHELTONIAN.—(1) Roughly speaking, the height to which the water can be lifted depends upon the depth to which the pipe is immersed. The higher the lift required the deeper must be the point at which the air is injected relatively to the normal water-level therein. (2) The air pressure at starting must, of course, be sufficient to overcome the pressure due to the head of water. A little more than the theoretical pressure should be allowed for. (3) Authorities differ as to whether the air pipe should go inside or outside the rising main. Perhaps in the majority of cases the air pipe is outside the rising main. (4) The relative diameters of rising main and air pipe generally employed are rather more than 2 to 1, though we have known cases where these figures have been departed from in both directions. (5) This question is answered under heading 1. (6) The water can be delivered straight into tanks through a bent pipe. Generally speaking, however, bent pipes are to be avoided as lowering the efficiency. (7) There is usually a receiver into which the compressor delivers. (8) Dirtiness or muddiness within reason should not affect the working of the pump.

INQUIRIES.

PARTINIUM.

SIR,—Can any of your readers tell me where the metal called partinium can be obtained? F. R.
December 20th.

STOP VALVES.

SIR,—We should be obliged if any of your readers could inform us where we could obtain a nickel alloy, suitable for valves and seatings working in connection with superheated steam. VALVES.
December 20th.

HEATING WITH WASTE STEAM.

SIR,—I should be obliged if any of your readers could give me any information regarding the Boulton system of heating with waste steam, and inform me whether it would be suitable for heating a large printing factory, containing 1,000,000 cubic feet, with the exhaust steam from a 20 to 25 horse-power engine. R. D. C.
December 21st.

DEATH.

On December 18th, at 5, Clanricarde-gardens, Tunbridge Wells, JAMES ROBERT MOSSE, M. Inst. C.E., aged 81.

THE ENGINEER.

DECEMBER 23, 1904.

STEEL.

On the 1st of July, 1904, we published an article describing the Niclausse boiler works of Willans and Robinson, Limited, at Queensferry, near Chester. We therein referred to the manufacture of a special steel, for making which an open-hearth 30-tons furnace was provided. The steel made was very largely the result of an exhaustive inquiry carried out by Mr. Kent-Smith, an able metallurgical chemist. For a time the manufacture of this steel was suspended. We are glad to be able to say now that the furnace has been started again. On Friday night a paper was read before the Institution of Mechanical Engineers which was the joint work of Captain Sankey, a member of the firm of Willans and Robinson, and Mr. Kent-Smith. On the 18th of November a paper, also on steel, by Mr. Seaton and Mr. Jude, was read before the same Institution and partly discussed. The paper read last Friday was treated as in some sense a sequel to its predecessor, and the discussion which followed it covered both papers. Of the last addition to the literature of steel we can only say that it was to a large extent, unintelligible. It consists of a statement of the results of a great number of experiments, representing an enormous amount of labour. We happen to know that it was prepared with much haste against time. The discussion which followed was driven along at such a pace that the authors of both papers have been compelled to say that their replies to the questions raised must be sent to the secretary for publication in the "Transactions." Instead of publishing the paper by Captain Sankey and Mr. Kent-Smith, we give a special abstract, from which our readers can arrive at some definite conclusions as to the nature of the material being made at Queensferry.

Having thus explained the situation, we may go on to consider what is the result of the recent movement in favour of the impact and nick tests for steel. It may be summed up, we think, in Mr. Longridge's words. If we take a "raw steel," heat it to a good red heat, and cool it how we please except in cold water, we have as fit a material as can be got. At all events, if this is not true, then it cannot be said that anything is true about steel. As speaker after speaker—men who may with reason be supposed to know all that is known about steel—stated his views, the truth seemed to become more and more apparent that steel is all things to all men—anything is possible of any steel, always assuming, of course, that it is of what is called good quality to begin with. We have already reported the first portion of the discussion. On another page will be found the second part. We commend it to the consideration of our readers. We think that the general conclusion drawn by engineers must be that they are little wiser than they were before, and it is very difficult to see in what way impact tests can help them. Thus, for example, a boiler plate may satisfy every ordinary test, and fail dismally to keep out small steel projectiles fired at it. But no engineer would consider that this militated against the merits of a plate which was not intended to protect troops, or to cover the side of an armoured train. A most undesirable complication has been recently introduced. We have now impact tests; that is to say, blows or their equivalent; repetition stresses (Wohler tests), and both combined with nick tests; but what constitutes a true nick test has yet to be settled. According to one authority, any reduction in sectional area is a nick; according to another, no sensible reduction is necessary. Thus, we can name a case in which certain excentric rods for torpedo boat engines, made of the highest quality steel, broke one after the other in the jaws. It was found that the fracture always started at the "pip," made by a dotting punch, when the work was scribed. The use of the dotting punch was discontinued, and no more rods were broken.

An examination of the whole question in the light of the latest enquiries leads irresistibly to the conclusion that no useful theory of steel can be based on the assumption that it is a solid. It would take more space than is available now to work out in detail the proposition that we have in pitch a material which, within very wide limits, behaves precisely as steel does. We hope to return to the subject. Meanwhile we may direct attention to some of the points of close resemblance between them. If we prepare a stick of pitch at such a temperature that it is fairly hard, and putting it in a testing machine pull it suddenly in two, it will break without any contraction of area; so will steel, provided the temperature is low enough, and sometimes at normal temperatures. If the tractive effort is slow, and the temperature just right, the pitch will contract in area, draw out, and behave just like steel. If we put a pitch bar into an Arnold's testing machine it will behave just like steel. If the temperature is high enough it will bend backwards and forwards, if low enough it will break across at the first blow. If we press a flat-ended punch on a cake of hard pitch, it will in time penetrate it. Tresca has shown that precisely the same statement is true of a lump of steel. The difference all round between the behaviour of steel and pitch is wholly in degree, not in kind. It is fairly well understood by many persons making tests that moderate differences in temperature have a potent influence on the results obtained. Others do not realise this at all; yet it is a point of very great interest for engineers. A case which came under our own notice some years ago may be cited. A lattice girder bridge of considerable span was being erected in winter in the Midlands. The rivets were delivered in the usual gunny bags, and stored in an open shed. From time to time rivets were taken by the inspector to the smith's forge and tested by being bent through a considerable angle cold on the anvil. One frosty morning all the rivets tested failed, and the inspector condemned a lot of a couple of tons. The contractor's foreman asked would he be satisfied if they complied with the specification in a couple of hours. He said "Yes." Some dozens of rivets were then taken in to the office, where there was a fire, and after a couple of hours, when they were tested, they all passed. Here about 20 deg. made all the difference to the contractor. We shall not now push the argument further. If our readers will try a few experiments with pitch they will be able to see for themselves how close is the analogy; how certain it is that the word "solid" is vague enough to cover a number of materials, apparently very unlike each other.

Returning to that form of impact (?) test which is being carried out at the National Physical Laboratory by Professor Carpenter, in which a bar is subjected to a multitude of rapidly alternating longitudinal stresses similar to those in a piston-rod, we wish to call attention to a new development advanced by M. Perrisse, the able French engineer who has investigated the phenomena of the extra-

ordinary locomotive boiler explosion which took place at St. Lazare terminus, and has already been described in our columns. M. Perrisse states that the rupture of the boiler began at the left-hand side in the belly plate of the barrel close to the fire-box. As there was no grooving, or corrosion, or imperfection, he attributes the fracture to a deterioration in the iron—there was no steel in the boiler due to a repetition of stresses acting lengthways of the barrel, brought about by the expansion and contraction of the Serve tubes. The fire-box tube plate was tied just under the tubes to the barrel belly plate by half-a-dozen palm stays riveted to the belly plate, and ending in screws secured to the tube plate. The novel theory advanced is that a group of stresses exerted in one direction so injured the iron that it lost its power of resisting stresses at right angles to those which did the mischief. The barrel was no longer able to bear the bursting stress inside it, and gave way. If it is really true that the repetition of longitudinal stresses to which every boiler is more or less subject, may make the plates incapable of withstanding the rending effort of the steam, then indeed a new terror is introduced into boiler engineering. So far as we are aware, it has always been held that the mischief done by alternating stresses is confined to the deterioration of the metal in the direction of the stress. But really, when we think the matter out, we see that the conclusion has been jumped at, because no one has considered all round what happens. But, furthermore, it remains to be proved that a specimen broken by impact tests has really undergone any structural deterioration whatever, outside the fractured area, and if so, what?

During the discussion on Friday night something was said in favour of standardising impact tests. As it appears that almost any desired result can be had now under some conditions, while under others congruity has no existence, the desire for standardising is very legitimate. But in what shall the standard consist? It is out of our power at all events, to formulate even any theory of standardisation which would meet all the conditions. To cite only one difficulty—How are the specimens to be prepared? as according to some authorities the microscopic scratches made by emery paper constitute "nicks" and falsify results. What is to be the degree of polish adopted? The entire question bristles with difficulties which can only be overcome by very full and free discussion.

TANK ENGINE DERAILMENTS.

THE last impression of the *Railway Review* contains an onslaught on tank locomotives, and is responsible for the statement that application has been made to the Board of Trade for the appointment of a committee to inquire into all the "tank-engine disasters" that have occurred from 1876 to the present day. It is, of course, open to anyone to make an application of this kind; but why the limit of retrospection has been fixed at 1876 we are unable to surmise. It is true that certain remarkable accidents have recently occurred to trains drawn by tank engines, as, for example, that at Waterloo on the Lancashire and Yorkshire, and the Llanelly derailment on the Great Western. In addition to these our contemporary has collected particulars of half-a-dozen instances in which tank engines have left the rails since 1882. This gives an average of 3·66 years per accident, which does not seem to be a very heavy indictment. It is worth while, however, to inquire why a tank engine should be more likely to run off the road than a tender engine.

According to Mr. Clement Stretton, the danger lies in the fact that tank engines "oscillate" more than tender engines. No definition of the word oscillate is given. We have often called attention to the peculiar "wandering" motion that some locomotives acquire when running at a particular speed on a straight bit of road; but this is not oscillation in any accepted sense of the word. No doubt what Mr. Stretton has in his mind is a jumping or rocking of the engine, more or less violent. We have then two questions to settle. Why should a tank engine oscillate dangerously, and why should a tender engine run without oscillating? Now, it was settled many years ago that the principal cause of oscillation, rocking, or general unsteadiness in the running of a locomotive is want of accurate balancing. Have we any reason to assume that tank engines must be worse in this respect than tender engines? We think not. If they are, then the want of balance, and not the type of engine, is in fault. If it be urged that the modern express engine has a bogie, and that this makes it safer, it may be replied that hundreds of express engines are running which have no bogies, and hundreds of tank engines which have. Thus we may eliminate bogies and balancing. The only difference left appears to be the presence of side tanks, and it remains to be proved that they can play any part in producing oscillation. Saddle tanks have, indeed, been called unsafe because they raise the centre of gravity. But the centre of gravity of the enormous engines introduced within the last few years is as high as that of any saddle tank engine, and no one calls them unsafe. However, saddle tank engines are few and far between outside contractors' works, and we have never met with one that could run very fast either with or without a train. Tank engines are fitted with traversing axle-boxes, but so are tender engines. In fact, there are multitudes of tank engines built off the same patterns as tender engines, and differing from them scarcely at all. Analysing and comparing things, we are finally brought down to the proposition that the only reason why a tank engine oscillates violently and a tender engine does not is because the tender keeps the engine quiet. Our own experience on the footplate at speed with a heavy train is that the tender and engine each "go as you please" pretty much, and it has yet to be proved that a tender can steady an engine more than a train can. It is true that there is a centre draw bar, two safety links, and two stiff buffers between the engine and the tender. But when a coupling is properly screwed up between a tank engine and a train it seems to us that the steadying conditions must be about the same. It may be that the tender being heavier than a van, and having stiffer springs, may be more competent to reduce oscillation; but we have no evidence that it is. So far it appears to us that no mechanical reason has been advanced in support of the contention that a tank engine is more liable to derailment than a tender engine. We presume that something can be urged in this direction; but it has not been urged as yet.

When we examine the available evidence about the six cases cited by the *Railway Review* we find that the Board of Trade reports throw no light on the questions we have raised. Thus, for example, General Hutchinson, reporting on an accident when an engine left the road in 1883 on the Great Eastern Railway, wrote:—"Heavy tank engines, such as No. 97, however suitable they may be for drawing heavy weights at slow speeds, should certainly not be employed for fast trains, and drivers when appointed to take charge of them should, I submit, be specially cautioned on the subject." Concerning which dictum we venture to ask, why not? In what way are they unsuitable for drawing fast trains? Again, Major Marindin, reporting on a derailment in 1882 on the South-Western, says:—"The tank engine was not of a class calculated for very fast running, for any oscillation which might be set up would probably increase the further the engine travelled when at speed." Again we ask, Why? and is not this a statement that might just as well be made concerning numbers of tender engines?

There are very good reasons why tank engines should not be used to work express traffic, but these have nothing to do with oscillation; indeed, a great deal of fast traffic is run both in this country and on the Continent by tank engines, which are, no doubt, specially designed for the work. To assert that a railway company must not attempt to use a tank engine for speeds of over 30 miles an hour appears to us to be absurd. There are, to be sure, shunting and goods tank engines which are not carefully balanced or kept in perfect order as regards the distribution of weight on the wheels, the play of axle-boxes in the hornplates, the condition of the tires, and so on. Such engines are now and then pulled out of a siding and compelled to take the place of an express engine which has broken down or is unable for some cause to get on without help. No doubt, an element of risk is at once introduced; but this is not because the locomotive is a tank engine, but because it is not a good tank engine.

It must be clearly understood that we are not defending the use of tank engines with fast trains. Our object is to elicit a definite statement of the reason why every tank engine should oscillate more than every tender engine. As we have said, there is no support of this proposition available at present. We can only hope that this article may elicit it. So far as we have got, the argument seems to be based on the occurrence of six derailments in twenty-two years. This is not a heavy record of crime, and even the Board of Trade inspectors admit in two of the cases that there were extenuating circumstances.

L.C.C. ESTIMATES.

OVER and over again attention has been directed to the waste of money which attends the constructive operations of the London County Council. The causes are manifold. One is that estimates are, as a rule, falsified, work costing much more than was intended because the extras that invariably crop up were forgotten or supposed to be covered by the terms of the contract—a form of a pecuniary delusion to which municipal bodies are very liable. A recent example of erroneous estimating is supplied by the further report of the Bridges Committee, dated 30th November, 1904. From this report we learn that the Council on 23rd November, 1897, 16th October, 1900, and 17th March, 1903, approved estimates of £5500, £5500, and £24,500, or £35,500 in all, to cover the cost of the acquisition of property and compensation payments in connection with the construction of the Greenwich footway tunnel. The total expenditure already incurred under these heads amounts to £57,029, or £21,529 in excess of the estimates approved by the Council. Certain further expenditure, the details of which are not yet available, will have to be incurred, including the costs in connection with some arbitration proceedings; this will not probably exceed a sum of £1750. The estimates, it will be seen, were out of all proportion wrong, and an attempt is made to excuse this costly blunder by attributing it to the awards made under arbitration to the Admiralty and the Greenwich Pier Company. The history of the London County Council is full of examples of ignorance concerning the value of interests which the Council proposes to absorb. Some of the members appear to think, indeed, no one has any particular rights whatever over property which may be wanted for municipal purposes. In the present case the Bridges Committee have to ask for a supplemental grant of no less than £23,350 to be spent in carrying out a scheme which no one seems to want. We are glad to see that the Finance Committee criticise the whole proceeding sharply. They say, after admitting that the money must be voted, that it is desirable that the history of this tunnel should be brought before the Council. When the Council, on 9th June, 1896, agreed to apply to Parliament for power to construct the tunnel, it was stated that the total cost was estimated at £70,500, viz., £65,000 for works and £5500 for the acquisition of land. The expenditure to date on construction amounts to £121,336, and the total sum which it is now estimated will have to be paid for compensation and purchase of property is £58,779, making a total estimated cost of £180,115, as against the original estimate of £70,500. We agree with the Finance Committee, who say that they "cannot help thinking that it ought to have been possible to frame a more satisfactory estimate of the probable cost of this undertaking than that originally placed before the Council."

THE RAILWAY COAL CONTRACTS.

THE greatest possible interest is being taken in the placing of the railway coal contracts for next year's supplies of locomotive coal to the various large railway companies who are partial to South Yorkshire best steam coal. The interest this year is all the keener from the fact that some of the newly-developed collieries in what may be termed the South Yorkshire coalfield seem likely to be competitors, and, anxious to get a stand in the market, are said to be inclined to make sacrifices. The situation is interesting, and may, so to speak, produce a surprise. So far as can be ascertained none of the large consuming companies, save the Lancashire and Yorkshire, has as yet made any offers, notwithstanding rumours to the contrary. It is, however, stated on the best authority that the leading thick seam coalowners have during the week sent in amended tenders at 8s. 3d. per ton, a figure which they consider ought to be obtained. The four great companies mostly concerned are the Midland, Great Northern, Great Eastern, and North-Eastern. It is believed that but little progress will be made until after the Christmas holidays. Most of the leading South Yorkshire collieries have of late years been so thoroughly developed that extraordinarily large outputs of coal are obtained, and safe financial contracts are much sought after. It is acknowledged that the locomotive coal contracts are amongst the best and safest in the market. The companies, with few exceptions, provide their own wagons, and these are promptly emptied and returned to the pits. Payment is prompt and bad debts are unknown. It cannot, therefore, be wondered that the contracts are sought after, as in many instances they keep the pits going when other orders are not available. It will not be without interest to note that in 1903 the Midland and Great Northern paid 8s. 9d. per ton on 12 months' contract. In the last half of that year the first-named company paid £310,093 for its fuel, against £312,434 in 1902. The Great Northern paid £163,711 in the last half-year of 1903, against £168,624 in the last six months of 1902. The North-Eastern, which obtained supplies at 8s. 6d. per ton at the beginning of the present year, paid £210,556 in the last half of 1903, against £212,785 in the last six months of 1902. Other large companies were similarly affected. The probability of a reduction of from 3d. to 6d. per ton on next year's supplies will make a material difference to the coal bills of most of the leading companies.

HIGH-SPEED CUTTING.

A CORRESPONDENT draws our attention to the enormous weight of metal per horse-power per hour removed in the turning record which we described in our issue of the 9th inst. on page 582. The machine in question was a 30in. shafting lathe, built by Messrs. Hulse and Co. for the Darlington Forge Company, Limited. It is fitted with a 60 horse-power electric motor, and removed on test with four tools cutting at the rate of no less than 4½ tons, or about 10,000 lb., of steel per hour. The test was short, and the motor was certainly overloaded; but, even supposing that it was developing double its nominal duty, say, 120 horse-power, the output per gross horse-power per hour was at the extraordinary rate of 83½ lb. With a single tool in operation, 30 lb. to 40 lb. is deemed very good work, and how we are to account for the fact that when four tools are used the work done per horse-power is over twice as much it is difficult to say. A machine tool is like all other machines, and, within limits, is most efficient when most highly taxed, for the simple reason

that the constant factors, internal friction, and so on, increase much less slowly than the rate of doing work; but, even with this fact to help us, the reason for this great efficiency is far from being found. We commend the problem to our readers, who may be able to adduce other instances of extraordinary output from multiple tools.

DOCKYARD NOTES.

THE French torpedo gunboat Condor, which gave recently so much trouble that her steaming capacity was almost nothing, has been overhauled in Toulon Dockyard, and a complete set of new steam pipes installed. She has just completed a series of trials, in all of which she has done excellently. The Condor was launched so long ago as 1885, and had a nominal speed of 17·5 knots. The engines are horizontal, the boilers cylindrical.

BILGE keels have been fitted to the French battleship Carnot.

THE mystery of the sunken Russian fleet at Port Arthur deepens, for the majority of the heavy Japanese guns do not appear to be over 8in. in calibre. The 8in. is a good gun, but with common shell at five-miles range its ability to penetrate 9in. K.C. belts was unsuspected hitherto. Probably, however, the Japanese have also some big howitzers, and high-angle fire, no matter how wild, is bound to tell if kept up long enough. It seems to have been kept up for some ten or twelve weeks.

IN her recent consumption trials the French cruiser Dupetit Thouars secured the record of 1·21 lb. per indicated horse-power per hour. The previous record holder in this direction was the Rusian cruiser Bayan with 1·4 lb. per indicated horse-power. The British record is held by the Vengeance, which was 1·5 lb. per indicated horse-power on her economical speed. Second place is held in our Navy by the Drake, which has once or twice got down to 1·55 lb. per indicated horse-power per hour.

THE cruiser of the Minotaur class to be built at Pembroke has been named Defence. The third of the class is the Shannon.

WOLSELEY engines will be fitted to the new submarines; whether the new vertical type will be used has not yet been decided; in the "B" class submarines horizontal engines are employed.

To the growing number of war material firms who are specialising in petrol motors the Belleville boiler firm is now added—some Belleville motor cars being one of the novelties of the Paris Show. The other firms now in the business are the Hotckiss Gun Company, Krupp, Vickers-Maxim—with the Wolseley and Siddeley cars—Thornycroft, and Willans and Robinson, the British makers of Niclausse boilers, who engine the Duryea cars.

IN future naval officers using their own motor cars for duty are to be allowed 6d. a mile. Thus will the motor industry be encouraged and economies effected under the item of cab allowances.

THE experimental French submarine "X" has been launched. Her petrol horse-power is 220. Her displacement is 168 tons; length, 125ft.; beam, 10½ft.; draught aft, when floating, 7½ft. She was designed by M. Romazotti, the inventor of the Morse, and does not greatly differ from that type.

THE French budget for 1905 consists of the following ships:—Edgard Quinet, armoured cruiser of 14,300 tons, 40,000 horse-power, and 24 knots; C 17, probably a sister; four destroyers—M 40-43—of 431 tons, 6800 horse-power, and 28 knots; 20 torpedo boats, 180 tons, of the 1900 programme—295-369; eight submarines—Q 53-60.

THE U.S. armoured cruiser Pennsylvania has made 22·5 knots on trial, thus beating the Colorada by ·21 knots. The Colorada, it will be remembered, beat the Virginia. The Colorada has Niclausse boilers, the others have the Babcock. The fight between the American and French type boilers is very keen in the American navy, and "honours are easy," or nearly so, thus far, neither type having proved itself distinctly better than the other.

CRYSTAL PALACE ENGINEERING SCHOOL.—The Wilson Premium for the best paper read before the Crystal Palace Engineering Society during the present session has been awarded by the Council to L. H. C. Palmer for his paper on "Railway Practice and Construction in India." Other papers read during the session were "Water Boring in South Africa," by W. D. Cornwell; "Portland Cement," by N. G. Watson; and "Irrigation in India," by N. H. T. Danell. Mr. S. Y. Knight—a former student—of the Llantwit Engineering Company, also read a paper upon "Railway Brakes." The premium was presented to Mr. Palmer by Mr. Charles Hawksley, past-president of the Institution of Civil Engineers, on the occasion of the ninety-sixth distribution of certificates at the above school on Friday, the 16th December.

SOCIETY OF ARTS.—The following are the arrangements for meetings during January, 1905:—Wednesday, January 4th, 5 p.m. (Juvenile Lecture): Carmichael Thomas, "The Production of an Illustrated Newspaper" (Lecture I.). Wednesday, January 11th, 5 p.m. (Juvenile Lecture): Carmichael Thomas, "The Production of an Illustrated Newspaper" (Lecture II.). Wednesday, January 18th, 8 p.m. (ordinary meeting): Captain Lionel James, "Wireless Telegraphy and War Correspondence;" Sir William Preece, K.C.B., F.R.S., will preside. Thursday, January 19th, 4.30 p.m. (Indian Section): Douglas W. Freshfield, "The Highlands of Sikkim;" Sir William Lee-Warner, K.C.S.I., will preside. Monday, January 23rd, 8 p.m. (Cantor Lecture): James P. Maginnis, "Reservoir, Fountain, and Stylographic Pens" (Lecture I.). Tuesday, January 24th, 4.30 p.m. (Colonial Section): C. F. Just, "The Manufactures of Greater Britain.—I. Canada." Wednesday, January 25th, 8 p.m. (ordinary meeting): The Hon. Robert P. Porter, "London Electric Railways." Monday, January 30th, 8 p.m. (Cantor Lecture): James P. Maginnis, "Reservoir, Fountain, and Stylographic Pens" (Lecture II.). Tuesday, January 31st, 8 p.m. (Applied Art Section): Edward Johnston and Graily Hewitt, "Caligraphy and Illumination."

SIR MORTIMER DURAND UPON THE ST. LOUIS EXHIBITION.

THE following despatch has been addressed to the Secretary of State for Foreign Affairs by his Majesty's Ambassador at Washington upon the British Sections at the St. Louis Exhibition:—

[COPY.]

No. 177. WASHINGTON, November 18th, 1904.

My Lord,—I have the honour to report that I have just returned from a visit to the Purchase Exposition at Saint Louis. The Exposition is on a very large scale, and many of the buildings and exhibits are really fine.

I think that his Majesty's Government has reason to be satisfied with the display made by Great Britain. The British exhibits were well housed, and attracted much attention. Though in many particulars they cannot be regarded as representative of the country, they are in some respects very good.

The British Art Section was generally regarded as containing the best collection of pictures in the Exposition. The Educational Section seemed to create general surprise. The pottery was greatly admired, and was selling freely. The Jubilee presents, which occupied a large separate gallery, were visited by a constant stream of people. The pavilions of the British Colonies and possessions were also much visited, and the Indian Commissioner seemed greatly pleased with the success of his exhibit.

On the 10th November I dined with President Francis, and the principal directors of the Exposition. President Francis proposed the health of the King, which was drunk with much cordiality by all the Americans present. I thanked them for this, and said a few words regarding the interest which the King and the Prince of Wales had taken in the Exposition. Thereupon President Francis made a speech in which he specially referred to the Jubilee presents, informing us that the decision of the King to send them over had been of the greatest help to him, inducing foreign nations to accept the Exposition as a serious affair, and to contribute liberally.

The Exposition breaks up early in December, after a visit by President Roosevelt.

I think our participation in it has had a good effect on the relations between the two countries, and that the expenditure involved was not unprofitable.

I have, &c.

(Signed) H. M. DURAND.

The Most Honourable the Secretary of State for Foreign Affairs.

PYROMETERS FOR INDUSTRIAL PURPOSES.

A MEETING of the Cleveland Institution of Engineers was held at Middlesbrough on Monday evening, 5th December, Mr. Robert J. Worth, of the Phœnix Engineering Works, Stockton, the president, in the chair.

Mr. Robert S. Whipple, of Cambridge, read a paper, of which the following is an abstract:—The author remarked that accurate temperature measurement is yet a problem of considerable difficulty. Temperature is not a measurable quantity in the strict sense of the term. It is not like measuring a length or mass, which assumes the existence of two laws—that of equality and that of addition. Temperature obeys the first of these laws. Two bodies in temperature equilibrium with a third will also be in equilibrium with each other. The other law is entirely lacking. By placing together several bodies at one temperature it is not possible to realise a system equivalent from the point of view of exchange of heat, to a body at a different temperature. Many scales of temperature have been proposed, but the gas scale is the one now universally adopted, and readings obtained by any type of thermometer—electrical, expansion, or optical—are reduced to temperatures on the gas scale. The gas scale has been adopted as the standard scale of temperature—first, because gas of the same purity can be reproduced at any time; secondly, the dilatation of the gas, which defines the scale of temperature, is sufficient for accurate measurement; and thirdly, the scale is practically identical with the thermodynamic scale. Although the scale of the gas thermometer has become the standard of reference, it is not necessary to use the gas thermometer itself in every-day life, but a thermometer which has been carefully standardised at certain known temperatures. Thermometers and pyrometers are generally standardised by means of fixed points of fusion and ebullition which have been determined by the gas thermometer.

It is perhaps for this very reason that many of the discrepancies in high temperature thermometry have arisen. The actual precision of the high temperature measurements depends on the accuracy to which these fixed points are known. It has so far been found impossible to determine many of those directly on the gas thermometer, as even the platinum-iridium bulb of the gas thermometer becomes porous at extremely high temperatures. High temperature thermometry is badly handicapped through the scarcity of materials capable of being made into a thermometer bulb and of standing high temperatures. Platinum is very permeable to hydrogen—a gas which is generally present where combustion is incomplete. Platinum, however, even when red hot, is practically impervious to all other gases, so that if nitrogen is employed as the gas whose volume is being measured, and the platinum is suitably protected from hydrogen, accurate observations may be made. Porcelain must be glazed to ensure non-permeability, and the glaze cannot be considered impermeable above 1100 deg. Cent. Water vapour passes comparatively easily through unglazed porcelain. As to the construction and working of the gas thermometer, the author refers those interested to Dr. Guillaume's treatise on "Thermométrie de Précision," and M. le Chatelier's book on "High Temperature Measurements."

The author then enumerates and describes the various means of measuring temperature in general use, and treats their particular applications. The types are expansion, thermo-electric, electric resistance, radiation, optical, calorimetric, fusion. Dr. Chree, in the *Philosophical Magazine*, has remarked that "the ideal mercury thermometer is one which accommodates itself at once and completely to the temperature, it is, for the time being, exposed to, and which, when exposed to a given temperature, supplies an invariable reading." There could not be a better definition of what is required from any form of thermometer.

With the mercury thermometer it is now possible to measure temperature with an accuracy of 0·001 deg. Cent. We in England have been far behind French and German practice in the construction of accurate mercury thermometers. Evidently, we have been standing still, while the National Physical Laboratories of France and Germany were developing the construction and materials of their thermometers. With our own National Physical Laboratory now well established under the direction of Dr. Glazebrook we are not likely to fall behind again.

The author considers the various errors found in a mercury thermometer, and the methods of determining the corrections to allow for them, such as corrections for parallax and refraction, scale and calibration, determination of boiling point and of freezing point, different temperature of scale or stem, pressure on the bulb. An expansion thermometer of general interest is the one in which temperature is measured by the unequal expansion of two materials, such as steel and porcelain or graphite. A graphite rod is placed at the bottom of a closed steel tube, a small steel tube being connected to the upper end of the graphite rod. By means of various simple mechanical movements the differential expansion of the two rods is indicated on a dial.

Mr. Whipple remarked that the Uehling thermometer always impresses him as being one of the most ingenious pyrometers yet constructed. Knowing the difficulties that a new invention entails, Mr. Uehling must be warmly congratulated on the ingenuity expended in developing his idea and on the success obtained by his pyrometer.

The second group, the thermo-electric thermometers, is that in which is measured the electromotive force developed by the difference in temperature of two similar thermo-electric junctions opposed to one another. M. le Chatelier and Sir William Roberts-Austen found out what metals to use for couples, what formulæ shou'd be employed, and what apparatus should be used. Platinum and an alloy of platinum, with 10 per cent. iridium, gives the largest electromotive force. The galvanometric method is simplicity itself.

The electric resistance thermometer was first proposed by Sir William Siemens in 1871, and it immediately came into general use in metallurgical work. It was found, however, that the pyrometer did not satisfy the fundamental criterion of always giving the same indication at the same temperature, and it was rather severely condemned by a committee of the British Association in 1874, who showed that these changes in resistance were due to chemical alteration in the platinum. These changes are very rapid if the platinum is quite unprotected, less rapid if it is protected by a steel tube, and disappears if protected by a porcelain tube. Professor Callendar has since shown that the platinum resistance thermometer, if protected from strain and contamination, is practically free from zero changes over a range of 0 deg. to 1200 deg. Cent., and that it always gives the same indication at the same temperature. The author then described the Callendar and Griffiths' resistance thermometer, as well as the Callendar recorder for determining the recalescent points of steel, and for general thermometric work. M. le Chatelier had referred to this recorder as the only one which records high temperatures by purely mechanical means, without the intervention of photography. That statement may not now be strictly true, but the author believes that the Callendar recorder still provides the most satisfactory way of mechanically drawing a temperature record. The author showed the continuous record of the temperatures registered by a Callendar pyrometer on the downtake of a Lancashire boiler, and a week's record of the hot air blast temperature obtained in a Midland steel works.

On every hand the "heat treatment" of steel is heard, and any one who has had anything to do with annealing knows the difficulty of maintaining ovens or furnaces at a constant temperature, partly owing to the negligence of the firemen, the master only learning a few days later from the tests on the material how badly the furnace has been fired. With a recording thermometer the negligence was shown at once. A recorder and thermometer specially adapted for annealing furnaces was exhibited by the author.

With respect to heat radiation and optical thermometers, the paper states that many workers have endeavoured to evolve a pyrometer that would measure the temperature of a source of heat without the necessity of inserting a "poker," as the Americans call an ordinary pyrometer. Of optical thermometers the one designed by Professor Wanners is believed to be the most successful, but it cannot be used for determining the hardening and annealing temperatures of many steels, as the lower limit of temperature is about 900 deg. Cent. An ingenious optical pyrometer has been designed by Holborn and Kurlbaum, working at the Physikalische Technische Reichsanstalt.

The author says he does not know of any heat radiation pyrometer that has been successfully applied commercially. Boys' radio-micrometer, although marvellously sensitive, is too delicate for the rough handling of every-day life. This is described, as is also Professor Langley's bolometer and Siemens' water calorimeter. As regards fusion thermometers, the author draws attention to an ingenious device invented by Messrs. E. H. Griffiths and Whetham, which appears to have a good future before it. An iron rod is held rigidly in a steel tube by means of an alloy, melting at any given temperature. The rod is free to rotate as soon as the alloy is melted, and can be made to ring an alarm either mechanically or electrically, or to shut off gas or steam. By a simple contrivance it can be easily re-set for another experiment.

The paper was well illustrated by diagrams and specimens of the pyrometers, &c., themselves.

OBITUARY.

WE regret to have to announce that Mr. John Allen McDonald, chief engineer of the Midland Railway Company, died on Sunday at his house at Borrowash, near Derby. He had not enjoyed the best of health latterly, but his death from angina pectoris was unexpected. He succeeded Mr. A. A. Langley as chief engineer in 1890. His principal task was in connection with the construction of Heysham harbour, for which he was joint-engineer with Mr. G. N. Abernethy. At the time of his death he was engaged on several other large works. Mr. McDonald was only fifty-eight years of age.

THE death took place last Friday of Mr. John Thomas, jun., who had for many years carried on business on Teesside. He was born in Kent in 1849, and settled at Middlesbrough in 1868, where he was associated with his father in carrying on the Acklam Refinery, where they produced refined iron, which was sent largely to Wales for the manufacture of tin plates. He afterwards became an ironfounder on his own account, and for the last quarter of a century he has had an extensive iron merchant's business at Middlesbrough.

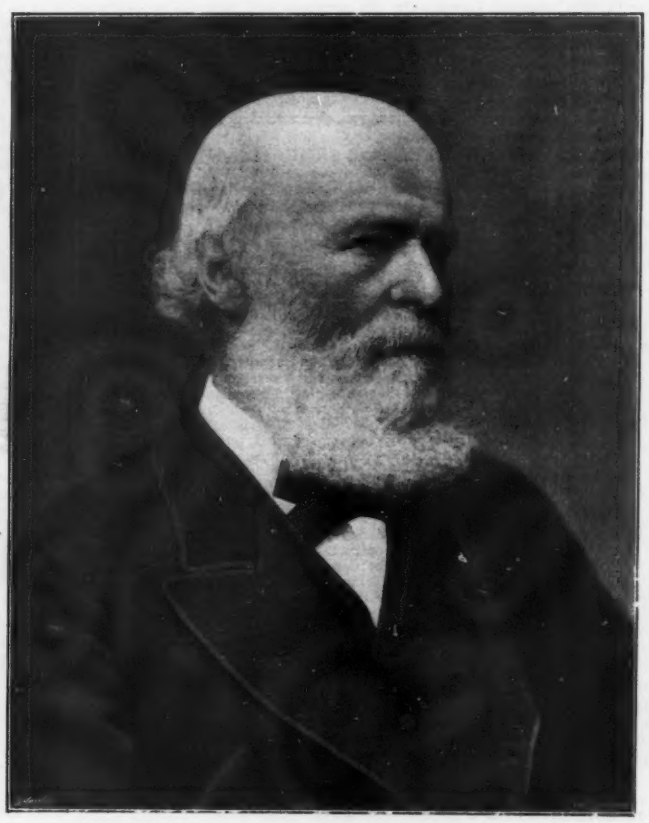
NON-METALLIC SYPHON.—A new non-metallic mineral water syphon has recently been put on the market by Messrs. Idris and Co., Limited, of King's-road, St. Pancras, N.W. Its special feature is that its contents cannot come into contact with metal either while the syphon is being filled or when it is at work. The construction is simple. There is first of all a china headpiece and spout combined, which is pierced with a central hole, and is provided with a rubber washer on its under side placed concentrically with the hole. The ordinary syphon body and glass tube are used, and the latter is flanged at the top. This flange rests on a rubber washer on the top of the neck of the body, and butts up against the washer on the underside of the china headpiece. On the top of the latter is a rubber disc valve which can be actuated by a lever. The whole is held in position by an aluminium cap which can be screwed down to the syphon body. Syphons of this type have been in use for the last twelve months, and have, so we understand, given good results.

PROFESSOR W. E. AYRTON gave an "Exhibition of experiments to show the retardation of the signalling current on 3500 miles of the Pacific cable between Vancouver and Fanning Island," at the last Physical Society meeting. The experiments were performed upon a cable electrically equivalent to the portion of the Pacific cable between Vancouver and Fanning Island, the product of the capacity—in mfds.—and the resistance—in ohms—being nine millions. Three dead-beat galvanometers were employed to indicate the current at the beginning, in the middle, and at the end of the cable. It was shown that upon applying an E.M.F. at one end of the cable, the current at that end was enormously greater than its steady value, and that one-fifth of a second elapsed before any indications of current were shown at the far end of the cable. By that time the current at the sending end was 3·7 times its steady value, and after two-fifths of a second it had fallen to 2·3 times its steady value. In about five seconds the current became steady.

SIR LOWTHIAN BELL.

ANOTHER of our great captains of industry—Sir Lowthian Bell—died on Tuesday, full of years and highly honoured, not only in the North of England, with which he was intimately connected, but also in every district and country where the manufacture of iron and steel is carried on. He died within a few weeks of completing his eighty-ninth year, at his home, Rounton Grange, Northallerton. Throughout his long career he has ever been an indefatigable worker, and put forth his best endeavours to bring science to the aid of practical work, and the scientific no less than the commercial world is much the poorer for his decease. He was everywhere looked up to as one of the leading authorities on the manufacture of pig iron, a distinction which he had well and truly earned, for he devoted a very considerable part of his life to patient and exhaustive research into the working of the blast furnace, and much of what we know of the reactions that take place in the operation of smelting iron has been ascertained by Sir Lowthian in the course of his investigations.

Sir Lowthian was almost the last of the pioneers of the Cleveland iron trade; in fact, his death leaves only two remaining of those who in the early fifties of the last century took prominent parts in establishing pig iron-making on the banks of the Tees. It was in 1851 that the first blast furnaces were started in the Cleveland district, Messrs. Bolckow and Vaughan building three at Middlesbrough; then Messrs. Gilkes, Wilson, Leatham and Co. erected two furnaces at the Tees Ironworks; and the Clarence Works of Messrs. Bell Brothers, with three furnaces, were started in January, 1854. Thus, Sir Lowthian and his brothers John and Thomas were the third firm to engage in the manufacture of Cleveland pig iron, and it was soon after the opening of the Clarence Works that Sir Lowthian commenced his scientific experiments, his attention being first directed to the application of the escaping gases as a means of heating the blast, little having been done up to that time with a view to utilising the waste heat from the furnaces. It may be remarked that Sir Lowthian had had experience in smelting Cleveland ironstone some years before there were any furnaces on the banks of the Tees, but that was on the banks of the Tyne in 1846, when connected with the firm of Losh, Wilson and Bell, he built one of the furnaces at Walker for the express purpose of smelting the ironstone now known as Cleveland, such stone being obtained from the foot of the cliffs in the neighbourhood of Whitby, Sir Lowthian thus fully deserved the distinction of being classed as one of the pioneers or fathers of the Cleveland iron trade, which has attained greater dimensions than that of any other pig iron making district in the world.



SIR LOWTHIAN BELL

Sir Lowthian Bell, it may be stated, was born at Newcastle-on-Tyne in February, 1816, and was one of the sons of Thomas and Catherine Bell, the family name of the latter being Lowthian. Both were natives of Cumberland. Sir Lowthian was educated at Dr. Bruce's school at Newcastle, and after leaving there he went to Denmark and Germany to study the languages of those countries. On his return he went to Edinburgh University, and thence to the Sorbonne in Paris. Afterwards he visited the South of France for the purpose of studying a process for the manufacture of alkali by the use of sulphur-hydrogen. Later on he had intimate connection with the chemical trade, as well as with the iron trade, for he joined his father-in-law, Mr. Hugh Lee Pattinson, F.R.S., in starting the Washington Chemical Works. Mr. H. L. Pattinson himself was a distinguished chemist, and was the patentee of a process, which was largely adopted, of extracting the silver from the lead ore. He also carried on the Felling Chemical Works.

Sir Lowthian Bell's first practical acquaintance with the iron trade was at the age of twenty, when he went to manage the rolling mills of Messrs. Losh, Wilson and Bell—in which firm his father was a partner—at Walker-on-Tyne. The firm had also established blast furnaces there, chiefly for using up mill cinder, the produce of the rolling mills, and it was there in 1846 that Sir Lowthian, as stated above, erected a furnace specially for smelting Cleveland ironstone. At Walker Sir Lowthian Bell made the acquaintance of Mr. John Vaughan, who afterwards was the discoverer of the main seam of Cleveland ironstone, and who joined Mr. H. W. F. Bolckow in establishing the pig iron trade on the banks of the Tees. Mr. John Vaughan had been the manager of rolling mills at Carlisle, and went to Walker to manage Messrs. Losh, Wilson and Bell's rolling mills. Sir Lowthian and his two brothers about this time also leased the blast furnaces at Wylam-on-Tyne, belonging to Captain Blackett, and there they carried on the manufacture of pig iron, partly from mill cinder and partly from iron ore obtained at Hareshaw, in Northumberland. Afterwards ironstone was collected from the beach near Whitby, and also at Skinningrove.

When Sir Lowthian Bell and his brothers were commencing as Cleveland ironmasters they became the lessees of the ironstone under the Normanby estate, but the lease was only obtained on condition that the works to be established to smelt the stone were placed on the north side of the river Tees, so that they might bring the coal from the Durham coalfield over the West Hartlepool Harbour and Railway, in which the Ward Jackson family, the owners of the Normanby estate, were interested. That was how the Clarence works came to be erected on the north instead of the south side of the Tees. The stone had to be carried from Normanby to the south bank of the Tees over a private railway—the Cleveland Mineral Railway—to a jetty, where it was loaded into barges and taken across the river to the works. The proposed construction of this private railway and jetty met with much opposition from the Stockton and Darlington Railway Company. After some years, when what is known as the Hartburn Curve, at Stockton, was constructed, the use of part of this railway and jetty was abandoned, and the ironstone was carried from the mines to the furnaces all the way by rail.

In 1864 Sir Lowthian's firm became colliery owners, as well as ironmasters. They acquired some of the colliery property thrown into the market by the collapse of the West Hartlepool Harbour and Railway Company, who had been extensive owners of collieries. Bell Brothers acquired the Page Bank Colliery, and became lessees of a very important tract of land from Lord Boyne, on which they sank the Browney Colliery. They afterwards started the Tursdale Colliery. Ironstone mines were likewise started at Skelton Park Pit, Huntcliffe Mines, and Lumpsey Mine. Limestone quarries in Weardale were acquired, and thus all the materials required in the manufacture of pig iron were in the hands of the firm, who now produce over 1000 tons of pig iron per day, and employ between 5000 and 6000 men.

In the scientific world Sir Lowthian was best known by his researches into the metallurgy of iron; but in his early days, when he was more intimately connected with the chemical trade, he and his father-in-law introduced several new methods into that industry, and Sir Lowthian himself devised a method of recovering the sulphur which was an essential element in the Le Blanc process; but that was superseded by other methods. Probably no ironmaster has devoted more time and pains to the study of blast-furnace practice, and his work has been universally considered as most valuable. The results of his investigations were communicated to ironmasters and others interested, chiefly through the medium of the Iron and Steel Institute, and were widely discussed, especially in the "seventies," both at home and abroad. One of the most interesting subjects studied by Sir Lowthian was the question of increasing the dimensions of blast furnaces, very varying views being held by ironmasters. Much information was given at meetings of the Institution of Mechanical Engineers and also at those of the Iron and Steel Institute, and the meetings were largely attended to hear the papers discussed. One notable paper was that read before the Institution of Mechanical Engineers in November, 1868, by Mr. Charles Cochrane, who discussed the influence of the height and diameter on the working of furnaces. In this paper Mr. Cochrane gave particulars of the working of a furnace which he had erected at the Ormesby Ironworks, which furnace had a capacity of 20,624 cubic feet. In that paper he expressed a hope that by increasing still further the dimensions of a furnace, enough heat might be conveyed into the furnace with the blast to enable a ton of iron to be produced from Cleveland stone with 13 cwt. of coke, a hope which has not yet been fulfilled. This paper brought out a rejoinder from Sir Lowthian Bell, in the form of a communication to the Iron and Steel Institute. In this it was held that there was a limit to the increase in the dimensions of a furnace, so far as economical production was concerned. Ironmasters in the North of England had been going on building higher and higher furnaces, until whereas the old furnaces had been only 40ft. to 50ft. high, some were built in the district which were 103ft. high. Sir Lowthian contended that with these very high furnaces the gases became too much cooled before they got through the materials in the furnace, and it was difficult to carry on the work of smelting economically owing to this. The paper read by Sir Lowthian was entitled "The Development of Heat, and its Appropriation in Blast Furnaces of Different Dimensions." The controversy was carried on for a very considerable time, Sir Lowthian Bell and Mr. Cochrane being the chief contributors to it. Sir Lowthian Bell, it may be remarked, was an admirable speaker, not only on scientific subjects, but also on social topics.

Sir Lowthian earned great repute as an author. He was a prolific writer on both technical and commercial questions relating to the iron and steel industries. His first important book was published in 1872, and was entitled "Chemical Phenomena of Iron Smelting: An Experimental and Practical Examination of the Circumstances which Determine the Capacity of the Blast Furnace, the Temperature of the Air, and the Proper Condition of the Materials to be Operated upon." This book, which contained nearly 500 pages, with many diagrams, was the direct outcome of the controversy mentioned above, and gave details of nearly 900 experiments carried out over a series of years with a view to finding out the laws which regulate the process of iron smelting, and the nature of the reactions which take place among the substances dealt with in the manufacture of pig iron. The behaviour of furnaces under varying conditions was detailed. The book created quite a stir in the metallurgical world, and became practically a text-book which has proved of the greatest utility to students of pig iron making. It was a monument of patient research, which all practical men could appreciate.

Another large work—750 pages—was entitled "The Principles of the Manufacture of Iron and Steel," issued in 1884, and in this the author compared the resources held by different localities in the Old and New Worlds as iron-making centres. His further investigations into the manufacture of pig iron were detailed, as well as those relating to the manufacture of finished iron and steel.

In 1886, at the instance of the British Iron Trade Association, of which he was then President, he prepared and published a book entitled "The Iron Trade of the United Kingdom Compared with other Chief Ironmaking Nations." Besides these books and numerous papers contributed to scientific societies, Sir Lowthian wrote more than one pamphlet relating to the history and development of the industries of Cleveland.

In 1876 Sir Lowthian was appointed a Government Commissioner to the Centennial Exhibition at Philadelphia, and had to write the official report relating to the iron and steel industries. This was issued in the form of a bulky Blue-book.

As a director of the North-Eastern Railway Company Sir Lowthian prepared an important volume of statistics for the use of his colleagues, and conducted exhaustive

investigations into the life of a steel rail. Sir Lowthian has been juror at several of the great British and foreign Exhibitions.

Sir Lowthian Bell, it may be remarked, was one of the founders of the Iron and Steel Institute. The iron-masters and manufacturers of the North-east of England had from time to time met at Newcastle, and had papers read to them relating to their business. It was thought that an organisation might be established which would be international, and those who were favourable to the idea met at Sir Lowthian's house in 1868 to talk over the matter. The outcome of that meeting was the formation of one of the most successful and important scientific societies, which now numbers among its members the leading metallurgists in all parts of the world. Sir Lowthian Bell was its third President, and during his term of office in 1873 the Institute held its first meeting oversea, when Sir Lowthian delivered his presidential address in French, one of the several languages with which he was perfectly familiar. The Institute, in 1874, bestowed upon him its first Bessemer medal for his distinguished contributions to the science of iron making. Sir Lowthian was also awarded the gold medal of the Society of Arts.

For his scientific work Sir Lowthian was honoured by many of the learned societies of Europe and America. He was a Fellow of the Royal Society; Hon. D.C.L. of Durham University; LL.D. of the Universities of Edinburgh and Dublin; D.Sc. of Leeds University. He was one of the most active promoters of the Durham College of Science by speech as well as by purse; his last contribution was made only a short time ago, and was £3000, for the purpose of building a tower. He has held the presidency of the Institution of Mining and Mechanical Engineers, and was the first president of the Newcastle Chemical Society. In 1873 he gave evidence before a Parliamentary Committee on the coal question, and when he was Mayor of Newcastle (an honour which was twice bestowed upon him), the British Association met there in 1863, and to Sir Lowthian was due much of the great success of that meeting, which was memorable in that attention was first directed to the probable extent and duration of our coal supplies. Sir Lowthian was a most munificent supporter of all efforts that tended to the spread of technical and scientific education.

Sir Lowthian was a director of the North-Eastern Railway Company since 1865, when that company acquired the West Hartlepool Harbour and Railway Company's line, and also of the private Cleveland Railway. For a number of years he was vice-chairman of the North-Eastern Railway board of directors, and at the time of his demise was the oldest railway director in the kingdom. In 1874 he was elected M.P. for the Borough of Hartlepool, and continued to represent the town till 1880. In 1885, on the advice of Mr. Gladstone, a baronetcy was conferred upon him in recognition of his great services to the State. Among other labours he served on the Royal Commission on the Depression of Trade, and formed one of the Commission which proceeded to Vienna to negotiate Free Trade in Austria-Hungary.

For twenty years prior to 1876 he resided at Washington Hall, County Durham; then he purchased the Rounton Estates, near Northallerton, and resided at the Grange ever since; there he was gathered to his rest on Tuesday. He is survived by two sons and three daughters. Alderman Hugh Bell, the eldest son, has twice filled the mayoral chair of the Middlesbrough Council, and the younger, Col. Charles Lowthian Bell, has also occupied the same office there.

THE NORTH BRITISH RAILWAY.

FOR some time past the North British Railway Company has been engaged in carrying out widening operations between College Station and Bellgrove, with a view to improving traffic facilities to and from the former station, which is in course of being completely re-modelled and brought up to date, and at the same time greatly enlarged, and so doing away with the frequent long and unavoidable delays arising from congestion of traffic, both passenger and goods, over the present low lines between College and Bellgrove. These operations have involved a great deal of heavy work in retaining walls, bridges, and covered ways, the line being carried under six streets, and also under the Corporation Cattle Markets and Slaughter-houses, between Moore-street and Bellgrove-street. These works are now all completed, and the permanent way is being laid down, so that the company should soon begin to reap the benefit of that portion of the extensive improvement it is carrying out on this portion of its system.

A more interesting part of the work, however, lies in the enlargement and re-modelling of College goods station, for which the widening of the railway is to serve as an outlet. The present goods station is to be entirely swept away, and the new station will embrace, in addition to the area occupied by the old station, that large portion of ground which lies to the north of the present station between High-street and Alexander's School, and facing Duke-street. The old buildings on this ground, some of them in ways quite historic, and which formed a part of that old Glasgow now fast disappearing, were cleared away some time ago, and for several months Messrs. Robert McAlpine and Sons, who are the contractors for the works in connection with the new station, have an army of workers busily engaged on the site.

The new station will be in two separate and distinct portions, one for general merchandise and one for mineral traffic, the former being built on the site of the old station and adjacent ground, and the latter on that portion of ground between Hunter-street and Barrack-street, facing Gallowgate, known as "The Barracks," and lately occupied by "The Carnival." This piece of ground is being laid out as a mineral depôt, access for railway traffic being obtained by a new bridge constructed under Barrack-street, at the north-east corner of the ground and to the south of the old bridge carrying Barrack-street over the passenger lines from Queen-street Low-level Station, while convenient cart access to the ground is got from Gallowgate.

The principal feature of the general station will be the large warehouse which is now under construction, and the walls of which can be seen rising above the barricading along Duke-street. The warehouse is to be 500ft. long and 321ft. broad, and will meantime consist of three upper floors and basement floor, provision being made for the addition of another floor as soon as the growth of traffic warrants the extension. The rails will run into the warehouse on the level of the lowest of the three upper floors, ten sets of rails being required, which will traverse the whole length of the warehouse, and not far short of a mile of railway track will be laid inside the building alone. Three roadways for lorry traffic and five loading tables for handling goods will be provided on this floor to deal with the traffic, and any goods which are not to be removed from the warehouse at once can be raised to the upper floors or lowered to the basement through openings and traps in the floors for storage till required.

The basement floor is extended beyond the area of the warehouse proper to the east of the building by arched vaults for a distance of 50 yards under the station sidings, and this floor should be useful for bonded store purposes, or a portion of it may be fitted up for cold storage for perishable goods. Access to this floor is obtained by a separate gateway and inclined roadway off Duke-street close by Alexander's School. The main entrances to the station and rail floor of the warehouse will be two in number, and are off High-street, and situated immediately on either side of College passenger station offices, the one on the south side of the offices being new. To give access to the yard from the latter entrance, a bridge has been thrown across the passenger station. At the point where High-street and Duke-street join a fourth access is being formed, and from this corner a cartway will rise to the level of the second of the upper floors, and run along the building from west to east immediately inside the wall facing Duke-street, so that cart traffic to and from the stores on the upper floors can be conducted without encroaching on the valuable space on the rail floor. Goods on the uppermost of the two storage floors will be lowered to the lorries on the roadway below through trap-doors in the floor. The chief idea throughout has been to prevent congestion of the different sets of traffic, and it is hoped that this plan of having separate roadways for each set on different levels, and each roadway, with its separate entrance, will meet the object in view. As already mentioned, goods will be raised to the upper floors from the rail floor through openings in the floors. These openings will each be of considerable area, being almost 40ft. long by 25ft. broad, and will, in addition to serving as a means for raising and lowering goods to and from the upper floors, form openings for ventilating, and, to some extent, lighting from the roof the lower floors. The building will be made fire-resisting throughout.

One of the most important points in connection with a building of this class is the nature of the equipment for handling the goods, and in this case all the machinery is to be worked electrically. A large number of overhead travelling cranes is to be introduced in place of the more usual jib cranes fixed on the floor level, with a view to economising floor space, though a few of the latter kind will be used in special cases. These travelling cranes will be distributed over all the three upper floors, the basement floor being served by those on the rail floor. In addition, there will be a number of hoists communicating with all the floors and the basement.

On the rail floor a feature will be the method of dealing with the railway wagons inside the warehouse. No engine will be allowed inside the building, and all the movements of the wagons will be conducted by means of electric capstans and traversers. The rails will run into the warehouse in sets of two or three, one road in each case being a feeding road for bringing in empty or removing full wagons.

By means of a series of traversers installed between adjacent lines of rails, the empty wagons, after being pulled into the feeding road by the capstans, will be traversed across from that line to the adjacent lines alongside the loading tables, the wagons being thus brought as near as possible to the point at which they are required. In the case of removing wagons which have been emptied at the tables or have received their load, the operation will be reversed. This method minimises the interference with the work of loading and unloading other wagons, and greatly expedites the handling of the traffic.

For dealing with specially heavy roads, a large Goliath travelling crane, capable of lifting 30 tons, is to be installed in the yard close by, and should prove extremely useful in handling this class of goods.

The work has been in progress now for some time, and, though most of it has, as yet, been of the nature of foundations and does not make much show, a considerable advance has been made, so far, by the contractors.

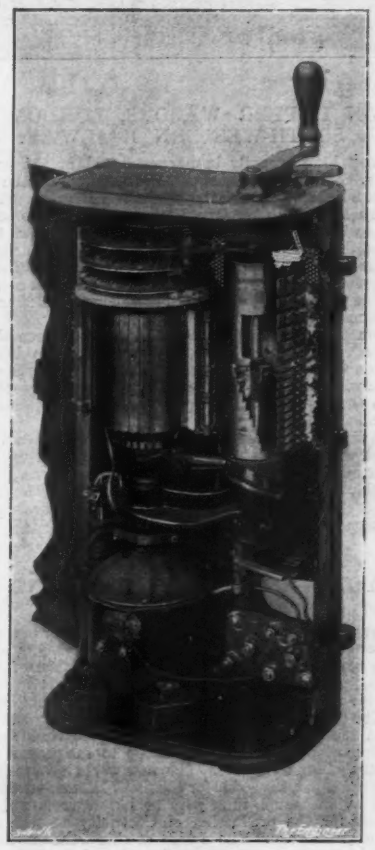
In addition to the works at College, and forming part of the same extensive scheme, there has just been completed at Shettleston a marshalling yard for the accommodation and marshalling of the traffic arising from College, &c., and, further, the widening of the line, which at present has only been carried out to Bellgrove, is to be immediately extended to Parkhead. As already pointed out, the saving effected in expeditious handling of traffic and quick despatch and marshalling of the trains, as well as the avoidance of long and expensive delays to trains, should be a great benefit to the company, both financially and otherwise, and should lead to substantial development of the goods traffic of the company in this quarter—a development which the greatly increased accommodation and facilities of College Goods Station itself should enable the company to look forward to with equanimity.

All these works are being executed to designs prepared by, and under the supervision of, Mr. James Bell, M. Inst. C.E., the chief engineer to the railway company, Mr. Charles J. Brown, Assoc. M. Inst. C.E., their assistant engineer for new works, being in direct charge.

MOTOR SPEED CONTROLLER.

A NEW method of obtaining varying voltage for the control of motors has been devised by the American Electric and Controller Company of New York. Many of our readers will be aware of the advantages of this method of controlling the speed of electric motors. Two of these are that there is almost constant torque at all speeds for a given work, and that there is no tendency to sparking throughout the entire range of speed variation. Both of these are of great importance, and a great many methods for obtaining the necessary variation in potential when dealing with current from a constant potential source have been invented. In one of these a motor is employed to drive a generator, which latter supplies to the working motor a voltage which is varied by the rheostatic control of the generator. In another case a storage battery is introduced. Other systems depend upon the possibility of varying the original voltage.

The principle of the actual method under discussion consists in only connecting the working motor to the supply circuit intermittently. The result of this is that the effective voltage at the motor terminals, as measured by a voltmeter, is less than the supply voltage, as it has not time to reach its maximum before it is again interrupted. The time of connection with the supply circuit can thus be varied between the full voltage and half the voltage of the mains. The apparatus by means of which this is brought about is shown in an engraving below. At the bottom on the left is a small electric motor, with its spindle placed vertically. This is coupled directly to an apparatus which is very similar to an ordinary direct-current commutator—that is to say, it consists of a number of bars of copper, each separated from the other by a strip of insulating material. This commutator—or interrupter as it should rather be called—is rotated at a constant speed of 1500 revolutions per minute by a motor connected to the supply mains. Two sets of carbon brushes press on the interrupter along diametrically opposite lines. On the right-hand side at the top is an apparatus not unlike the barrel of an ordinary tramway controller. By means of this a greater or less number of segments of the interrupter can be put into or out of circuit. When all are in the full voltage is on the working motor. When the least number are connected, then practically half the original voltage is the result. Further regulation is obtained by alteration in the field of the motor.



MOTOR SPEED CONTROLLER

We have received a copy of a series of tests made with a 31in. Rogers Machine Tool Company's boring mill fitted with a speed controller of this type. It will be seen that in each case quoted, although the work was facing in one case and reducing diameter rapidly in the other two, it was possible to increase the number of revolutions so regularly as the tool advanced towards the centre that the cutting speed was almost constant.

	Test 1. Heavy cast iron flange reduced from 15½in. to 8in. in diameter.	Test 2. Cast iron flange reduced from 15½in. to 9in.	Test 3. 24½in. hard cast iron flange surfaced to a diameter of 12½in.
Total time taken .	3 m. 38 sec.	2 m. 8 sec.	4 m. 25 sec.
Maximum speed ..	125	78	125 momentary 102 constant
Minimum speed	115	72	98
Average speed	120	75	100
Depth of cut and feed	¼ deep	¼ deep × 1/16 feed	⅛ × 1/16
Electrical input to motor	3·73 E.H.P.	6·1 E.H.P.	6·44 E.H.P.
Electrical output to machine	3·42 H.P.	4·92 H.P.	5·28 H.P.

We are pleased to notice that the tools used in these tests, which were made at a very high speed, were produced in this country. They were made from "A.W." steel manufactured by Sir W. Armstrong, Whitworth and Co., of Openshaw. The same tool was employed in tests 1 and 2 without re-grinding, and, the tool in the third test being uninjured, the cut was continued down to 3¼ in. diameter at the same average speed.

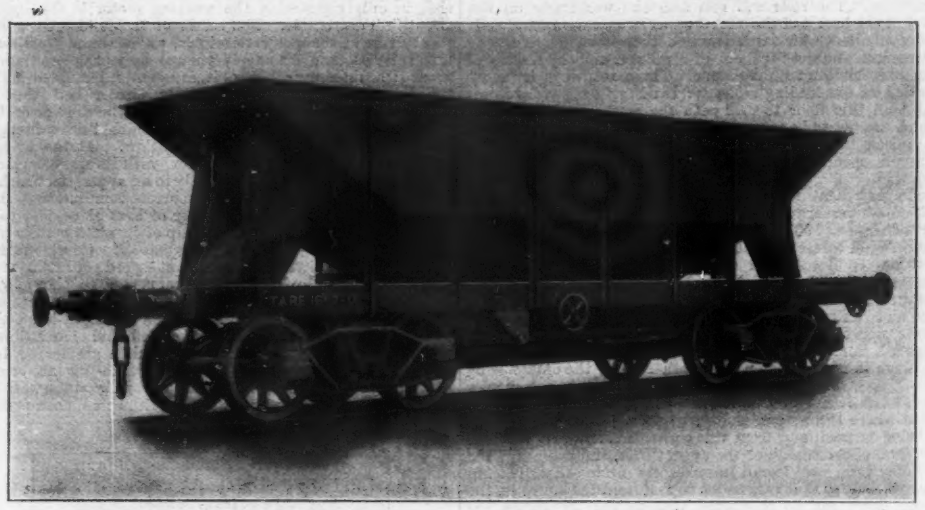
BOOKS RECEIVED.

Private House Electric Lighting. By Frederic H. Taylor. London: Percival Marshall and Co., 26-29, Poppin's-court, Fleet-street, E.C. Price 1s. net.

The Progress of the German Working Class in the Last Quarter of a Century. By W. J. Ashley. London: Longmans, Green and Co., 39, Paternoster-row. Price 1s. 6d.

40-TON BALLAST HOPPER WAGON

G. R. TURNER, LIMITED, NOTTINGHAM, ENGINEERS



40-TON HOPPER WAGONS, LONDON AND SOUTH-WESTERN RAILWAY.

THERE have recently been constructed at the works of Messrs. G. R. Turner, Limited, Nottingham, sixteen 40-ton ballast hopper wagons for the Engineer's Department of the London and South-Western Railway. These are intended for use with this company's ballast plough vans, and to form part of the plant in connection with its large stone quarries at Meldon Junction, near Okehampton. The trucks are 32ft. in length over headstocks, with a capacity of rather more than 32 cubic yards, and are carried on two four-wheeled bogies of the diamond frame type.

From the engraving on page 614 it may be seen that the wagons are fitted with the automatic vacuum brake, in addition to a powerful hand screw brake actuating the blocks on all wheels. As a matter of fact, the photograph from which the engraving on this page was made was taken before the brake had been fitted.

The discharging gear is worked by a screw and hand wheel. In wet weather, should any of the ballast hold up on the incline at the ends, steps and hand-rails have been provided to enable a man to clear the material away. The drawing gives such detailed information that further description is unnecessary.

HYDRO-ELECTRIC POWER PLANT AT TURBIGO.

A NEW hydraulic-electric supply station was opened last October at Turbigo, in Italy. The power-house is situated on the banks of the Naviglio Grande, which starts from the Ticino, not far from Tornavento, taking from it a volume of 60 cubic metres of water per second. The canal, which is about 50 kiloms. long, is used for irrigation purposes. It is one of the largest irrigation canals in the world, and the most important in Lombardy, but up to the present time it has hardly been navigable. The new works have made it an industrial canal, navigable for the first 7 kiloms.—4·347 miles—and at the same time part of its water is utilised in turbines for the production of electricity at the central station at Turbigo. The design of this work was first conceived by the engineers Conti, Greppi, and Seoli, but it was afterwards taken up by the Lombarda Company under the direction of Alessandro Scotti, who introduced considerable modifications to the first project. The new canal is diverted to the left of the Naviglio Grande in the district of Castellana, runs parallel to it for 2 kiloms., and then turns to Turbigo to meet the Naviglio again 600 m. above the bridge at Turbigo, the useful head being 8·70 m., and the mean flow 61 cubic metres per second. The corresponding available horse-power is 6659 dynamic, or 5530 effective horse-power at the axles of the turbines. From the water-regulating station to the power-house, the length of the canal is 5590 m., and the fall is at the rate of 0·12 m. per kilometre. The width at the bottom of the canal is 22 m., and the depth of the water 2·80 m. at the commencement, then the bottom contracts and the depth increases to 3·40 m. At 5400 m. from the regulating station the canal divides, the left branch, which carries away the least water, is used for navigation purposes, that to the right leads to the central station. The regulating station on the left of the Naviglio is provided with ten sluice gates, each 3 m. wide and 2 m. high. These sluices are so arranged as to allow 65 cubic metres of water to pass per second; 62 being for the central station, and 3 for the navigation canal. The roof of the building containing the sluices is raised above the level of the maximum rise of water in the canal, and is used as a public road. The entrance lock for the navigation canal is situated below the regulating station. This lock is 38 m. in length, and has a width of 6·50 m. at the surface, and 5·50 m. at the bottom, the gates being of the usual wooden type. At about 200 m. below the regulating house, the bed of the Naviglio has been barred by a sluice, which can be regulated to stop the water, and divert it into the new channel. This barrage is formed of 29 iron trestles spaced 1·20 m. apart, which turn on their lower ends, and carry a foot-bridge for the convenience of the attendant to enable him to get at the different controlling mechanism. This is raised 2·75 m. above the bottom of the Naviglio. On the right of the Naviglio there is a discharge with five outfalls, 2 m. by 2 m. The bottom is lower than that of the canal. With a view to maintaining the level of the water constant at the power-house, without causing any serious fluctuations of level in the irrigation canal, no matter what demands are being made by the turbines, a waterway 90 m. long has been constructed and three openings made in the side of the basin above the turbines. The openings have been provided with sluices, which are controlled automatically by electricity, the sluices being arranged to work in accord with the least variation of water in the basin. The water which escapes past these sluices rejoins the Naviglio by a canal, which divides the total fall of 8·7 m. into three steps. At each step a wall has been built ·80 m. high, so that the bed may be always covered with a depth of water and be protected against the effects of the falling water. In each of these walls are vertical openings, by means of which part of the water is discharged whilst the rest passes over the walls.

In order to ensure the uninterrupted working of the central station during the months when the Naviglio is dry, and also to be always able to discharge the excess water, there has been constructed at the right of the Naviglio and in front of the power-house a reservoir 23 m. wide, with six sluice gates leading into a channel, 857 m. long, which leads to the Ticino. This channel is capable of returning to the river the whole of the water from the new installation. The continuance of navigation is assured by two basins joined together by means of two locks, each of which gives a difference of level of 4·10 m. The dimensions are the same as those of the lock in front of the regulating station. The gates are of wood, and are provided with sluice valves, regulated by hand, for filling and discharging. A small channel runs along each basin and carries the constant supply of 3 cubic metres of water per second, which is necessary for navigation.

The power-house, which is built at the end of the new canal and to the left of the actual course of the Naviglio, is divided into two parts, the first of which is placed on the left of the incoming canal, and in direct communication with the supply basin formed by this canal at the lower extremity. This is exclusively used for the turbines. The second part of the central station consists of a large room 40 m. long, 40 m. wide, and 12 m. high. In this is the electrical machinery. The installation consists in all of five units. Four of these are working constantly, the fifth serving as a reserve. Each unit consists of a horizontal axis turbine of 1500 effective horse-power coupled directly by a rigid coupling to a three-phase alternator. There are also two small subsidiary groups for the excitation of the large alternators and for power purposes. These smaller units are driven by turbines of 100 horse-power each, and are coupled direct to their turbines by means of elastic couplings. Each of the five large turbines is designed to develop its 1500 effective horse-power under a head of 8·70 m., and with a volume of water of 18,000 litres per second, and at a speed of 125 revolutions per minute. They are constructed with two wheels on the same horizontal axle; the guide blades are controlled by levers, regulated by a chain. Each turbine has its automatic governor and two sluice valves, each having an aperture of 3 m. by 3·7 m. These valves are worked by hand, and each group of two has a grating of 6·5 square metres area in front of it. The triphase alternators are of the rotating field magnet type; the armatures are built up of bobbins, fixed to a suitable frame. Each alternator is constructed for a normal power of 1320 kilo. volt amperes, with a potential difference of 11,000 volts, and with a frequency of 50 periods per second. They have been designed for an output of 1050 kilowatts on inductive circuit, with power factor $\cos \phi = 0{\cdot}80$. There is an electric overhead crane, capable of lifting 25 tons, which serves for lifting and erecting machines. The cost of the hydraulic works of this installation, inclusive of the cost of the land and compensations, construction of the basins, canals, the central station, and the channel of discharge into the Ticino, including also the cost of additional measures for irrigation purposes, was about 3,660,000 lire (£146,000), or about 733 lire (say £30) per effective horse-power for hydraulic work alone. In another similar installation constructed on the Naviglio Grande, but at Nizzola, this figure was only 485 lire. In the latter scheme the canal is the same size, but there is a fall of 28 m., whilst at Turbigo the fall is only 8·2 m. The electrical energy is to be transmitted from Turbigo at 11,000 volts by three overhead wires. The demand is greatest in the environs of Legano. Nearly 1000 kilowatts of energy will be used in the new spinning and cotton mills between Sacomo and Rho.

THE INSTITUTION OF CIVIL ENGINEERS.—STUDENTS' MEETING.—A meeting of students of the Institution of Civil Engineers was held at the Institution on Friday evening, the 16th instant, Mr. G. N. Abernethy, M. Inst. C.E., in the chair, when a paper on "Folkestone Harbour: Cylinder Sinking at the Root of the Old Pier," was read by Mr. R. H. Lee Pennell, Stud. Inst. C.E. The reading of the paper was followed by a discussion, in which Messrs. T. S. Nash, H. M. Rootham, H. W. FitzSimons, B.Sc., and A. E. Snape, B.Sc., Studs. Inst. C.E., took part.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

A TURNING RECORD.

SIR,—In the issue of THE ENGINEER dated December 9th, 1904, on page 582, you give, under the heading of "A New Turning Record," some very interesting data pertaining to work performed by a 30in. centre electrically-driven lathe, erected by Messrs. Hulse and Co., of Manchester. You tell your readers there that the lathe removed 168 lb. of metal per minute with four tools working, the cut being 1¼in. deep by ⅜in. traverse, at a cutting speed of 44ft. per minute. This is without doubt a remarkable performance, and when I read it, it set me thinking what horse-power would be required to make such an enormous reduction. If we work with the formula of the very learned Professor Flather:—

$$\text{Horse-power} = \cdot 039\, w,$$

$$\text{We get,} \quad \text{Horse-power} = \cdot 039 \times 168 \times 60$$

$$= 393 \cdot 12 \text{ horse-power.}$$

This also is an enormous quantity, is it not? For illustration of this lathe you refer your readers to the Machine Tool Supplement published with THE ENGINEER, date November 4th, 1904. The lathe, I take it, is the one illustrated on page vii. of that Supplement, and upon reading through the matter I find that it is driven by a 60 horse-power motor only. Now the lathe takes a cut allright that requires 393 horse-power, and yet there is only 60 horse-power in the motor. Where does the extra power come from!

I argue that the power, in passing from the motor—or belt—to the point of the cutting tool, or to the spindle, is multiplied according to the ratio of the gearing through which it passes; but several of my friends, in whom I confide on such matters as these, say that such is not the case, and that you cannot get more power at the spindle than there is in the motor or belt. I am nearly convinced that I am right, for being interested on this point I have made many calculations—using Flather's formula—with belt-driven lathes, and have found that in many cases the power required to take a certain cut at a certain speed, after seeing lathe actually doing same, must have been far in excess of what the belt could possibly transmit without very soon causing its destruction, and yet the belt pulled the cut as smoothly as possible. I quote the case of Hulse's lathe here as being the best example I have come across.

Now the gearing in this case is given as 34·87 to 1, and if the 60 horse-power in the motor is multiplied in that ratio, we have $60 \times 34 \cdot 87 = 2092 \cdot 2$ horse-power at the spindle—truly another enormous figure, even when making a suitable reduction for friction in the headstock, and is well in excess of the 393 required to remove the 168 lb. per minute as stated.

Now, Sir, what I want to know is, am I right in my argument that the power in the motor or belt is multiplied in its passage through the gearing to the spindle, in the same ratio as the ratio of such gearing!

Also, does Professor Flather's formula hold good when using high-speed steels to their fullest capacity, or is there no definite relation between the horse-power required and the weight of metal removed! From what I can gather up to now the horse-power required goes up in leaps and bounds as the cutting speeds and cuts are increased, and if such is the case, will not Flather's formula give a figure which is far below what is actually required! Is there any law which will give this quantity when using the high-speed steels!

Just another point I should like you to settle for me. Which is the correct diameter on which to measure the cutting speed at which turning is performed! Is it the outside diameter of work! or is it the diameter at point of tool! or is it fairer to take a mean between these two!

In the case in point, the outside diameter is 20in., making 8·4 revolutions per minute, which gives a cutting speed of 43·99ft. per minute; the diameter at the tool point is 17·75in., and this gives a cutting speed of 39·04ft. per minute. The mean between these two is 41·5ft. per minute. Of course, I recognise that there is not such a very big difference between them, but I would very much like to know which is correct. I see that you have taken the first method in giving the cutting speed on page 582, December 9th, 1904.

December 18th. ONE INTERESTED.

H.M.S. TERRIBLE.

SIR,—Your correspondent "Navalis" must learn that in matters such as that under discussion it is necessary to deal with them on a basis of fact, and not of dockyard gossip. He persists in asserting that the enormous consumption of fuel which occurred when the Terrible came home from China in 1902 was the result of leaks in the steam pipes. He has to account in this way for, in round numbers, about 2000 tons of coal. This coal would produce about 15,000 tons of steam, and he wishes us to believe that every day during her voyage about 336 tons of steam were let loose in the ship. As this was lost and carried away through the hatches and ventilators, water had to be supplied to replace it. Where does "Navalis" suppose 336 tons of fresh water per twenty-four hours came from? The whole story of leaking steam pipes is preposterous from first to last.

The performances of the ship have been invested with an importance that they do not possess. The engines and boilers did no better on one voyage than the other—at all events not a scrap of evidence has been given that they did. If any credit is due to any one, it is due to the captain or the navigating lieutenant. I have already stated that in every ship there is a speed at which she will burn least coal in making a voyage. The nearer she is kept to this speed the less will be her consumption. I will try and make clear for the benefit of "Navalis" what this means.

The power required to propel a ship varies in a ratio at least as great as the square of the speed. It is usually much greater, but I shall, to keep things simple, take it to be as the square, which is not far wrong for low velocities. The result is that the quantity of coal burned per hour varies as the cube of the speed and per knot as the square of the speed, because the time spent on a knot is halved if the speed is doubled, and so on.

Let, now, a voyage of 3000 miles be made, one half at 10 knots and the other half at 15 knots. The consumption at 10 knots will be 100 lb., say, per knot; at 15 knots it will be 225 lb per knot. We shall then have 1500 knots at 100 lb. = 150,000 lb. of coal, and 1500 knots at 225 lb. = 337,800 lb., and the total consumption on the voyage will be 487,500 lb. Let, now, the whole voyage be made steadily at 12 knots, and we have a consumption of $144{,}000 \times 3000 = 422{,}000$ lb. Here is a saving of 65,000 lb. of coal—a very noteworthy economy to be credited to the ship, or her engines, or her engineers, but really due only to the fact that she did not reach her destination by spurts. No possible lesson can be drawn from a comparison of the performance on two or more voyages unless all the circumstances are known.

So far, I repeat that not one scrap of evidence has been supplied to prove that the boilers or engines of the Terrible have done better lately than they have done before. I do not say that they have not. All that my assertion comes to is this, that more care has been taken to run the ship at economical speeds during her last two voyages than heretofore. The hypothesis about leaking steam pipes is beneath contempt. No sea-going engineer in the Navy or out of it will credit it.

Lastly, I may say that I think it much to be regretted that attempts should be made to establish a high reputation for a ship or her engines and boilers, based on idle dockyard and club gossip. I know that much that is said becomes magnified in a curious way by some folk, and finds its way at last into the columns of the Press and even into parliamentary discussions. Thus this gossip assumes an importance that it does not deserve, and that is

my reason for troubling you with a long letter intended to correct misapprehensions which may easily become misleading and even mischievous aspersions on the professional reputation of able engineer officers. SUPERINTENDENT ENGINEER.

Liverpool, December 19th.

SIR,—"Navalis" is wrongly informed. The Speedy's sister ships had locomotive boilers, not cylindrical. The locomotive boilers gave 3000 horse-power during spurts; the Thornycroft boilers in the Speedy gave 4500 horse-power whenever wanted. An official publication says that the latter's boilers were fitted in 1891, and that in 1897 "This vessel has been continuously employed since her receipt from the contractors, and the boilers are working efficiently and economically." She has done seven years' better work since 1897.

I do not know how "Navalis" has gained the idea that the Terrible's steam pipe joints were wittingly designed too weak by the Admiralty, and that the engine contractors, who were then fitting merchant ships with steam of 200 lb., agreed with the design and guaranteed success.

His "fact" that the burst tube in the Terrible was an experimental weldless tube is opposed to the general belief that all her boiler tubes were lap-welded tubes, and that the tube burst at its thinnest part, which is never the weld. Salt feed and bad circulation was the cause of the fatality, as also, soon after, in another Belleville ship having weldless tubes.

No doubt some better results have been obtained by working with steam pressures as low as possible, but with this low pressure it is anomalous that any Belleville ship does give a horse-power for less than 2lb of coal per hour for main engines only. Easing or stopping the sanitary pump, has also given economy in coal.

It is a pity that the Boiler Committee did not raise steam in a Belleville by steam coils, open all casings, and so visually note the tightness of all screwed and other joints, and measure the actual loss of water.

"Navalis" vouches for the correctness of the Terrible's figures, having seen the ship's logs. He hints at incorrect powers in 1902 May I ask if they accord with receiver pressures and revolutions? Other items would be interesting to dispel mystery, the most important being the truth of the coal figures so far as boilers are concerned. Then there is the question of propellers, of alterations of auxiliary machinery working, of ages of coal burned, of use of boilers whether firing from forward or aft, and other details which would be instructive to engineers. PERPLEXED.

December 19th.

SIR,—Your correspondent "Navalis" is well posted up in the engine-room affairs of the Terrible. The point he raises about steam pipes is one of much importance, and ought to be thrashed out. In an ordinary way there is no more difficulty in making tight steam pipe joints for 350 lb. than for 150 lb. I gather, therefore, that the case of the Terrible must have been exceptional, and "Navalis" will do good service if he will tell your readers why the pipes leaked, and where, and whether an entirely new lot of steam piping has been put in; and if so, in what way it differs from the old. There are so many wild statements made about the Navy that an impartial, well-informed man, such as "Navalis" obviously is, should tell us all he knows, and not rest content with hints and innuendoes. TIFFY.

Devonport, December 20th.

NEW PATENT LAWS.

SIR,—On the 1st of January next our system of granting patents for inventions is to be so radically altered, that it is of importance to many of your readers to be somewhat acquainted with the cause of and probable effect of this new system. Hitherto patents have in this country been granted without any official examination as to the novelty of the invention. In future, there is to be an official examination as to novelty, but the examiners are only to consider previous British complete patent specification fifty years back; no foreign patent specifications nor any other publications are to be regarded. We have here a glaring instance of the step-by-step or piecemeal character of British legislation. In another twenty or forty years we may, perhaps, after an enormous expenditure of talk and print, expect an extension in the direction of an official examination like that carried out under the American, German, and other patent laws, which profess to and more or less take into account all publications. However, the principle is there, and, moreover, it is to be carried out in an entirely new manner. Where in other countries an official examination exists, there has been the power of refusing a patent for want of novelty or of "sufficient" novelty. The terrors and errors of irresponsible officialism thus let loose are so well known that I need only say that many a valuable invention is lost or mangled thereby, and many an invention obtains a patent undeservedly. On the other hand, the granting of patents without an official examination, according to the system at present in use in this country, France, most of our Colonies and many other countries, induces uncertainty as to the value of a patent, and hence great difficulty in its being taken up and commercially worked.

The essence of our new system is that though an official examiner may find that the invention sought to be patented is more or less anticipated, and though the Patent-office shall have the power to insist upon such alleged anticipation being inserted in the complete specification, after the applicant for patent has vainly tried to overcome the objection, yet the Patent office shall have no power to refuse the grant of the patent. That principle is right, in my opinion, but it is of the utmost importance that it be carried out in a fair, liberal, and commonsense manner.

That there is a great danger in the opposite direction is my firm belief. Although the present chief examiners on the whole may be trusted to act rightly, it will be different when, as they gradually by death or retirement vacate their places, these become occupied by assistant examiners who have not been educated under the present state of things. And there is always a fear of officialism if you give a young man the chance. It sometimes happens that the word comes true: "Convince a man against his will, he keeps the same opinion still." Every patent agent of lengthy experience in regard of patents applied for in countries where the examiners have to examine as to novelty, will bear me out in this, and human nature is the same in all lands.

It becomes, therefore, necessary to safeguard the interests of the inventor. The Press, and in this case the technical Press, has great power for good, if it is intelligently and perseveringly used. We know how often it produces "questions in Parliament," and they are generally effective in keeping officials straight, or in correcting abuses.

Before I go any further some people may say, "Why cannot the inventor himself do the search as to novelty?" My answer, from many years' experience, is that the inventor, as a rule, will not search; he trusts to luck, has no time, or, if he searches, he contents himself with going back a few years. Moreover, there are many inventors who are not able to pay for a proper search, instituted by a qualified patent agent.

The technical Press, then, should now take due notice of the matter, and lend a willing ear to all remarks, complaints or otherwise, that inventors, patent agents, and other interested parties have to say. In due course we shall, no doubt, have "papers" read and books printed on the working of the new system, but the matter should not be left alone in the meantime. From the Act and from the rules we may already gather sufficient information as to the defects, or possible defects, of the new system.

It goes without saying that a good examination, so far as it goes, necessarily implies good classification and good arrangement of the previous patent specifications. In this respect I have reason for stating that these requirements will be complied with. But the new rules contain certain provisions not anticipated by the Act, and objectionable;

Thus, Rule 5 seems to go in the direction of splitting up an invention needlessly, as requiring more than one patent, viz.: "When a specification comprises several distinct matters, they shall not be deemed to constitute one invention, by reason only that they are all applicable to, or may form parts of, an existing machine, apparatus, or process." If my specification, then, comprises a dozen improvements, all contributing to make the machine simpler, more efficient, and cheaper, then I may be required, as in Germany, to take out twelve patents for it! Though the Patent-office hitherto has been erring on the side of liberality, I fear that this rule may drive it to a noxious extreme in the other direction. And here I may state that in this and all other cases of decisions of the Comptroller there is a finally binding appeal to the law officer. This is very objectionable unless he, of his own initiative or by consent of the inventor, take to himself a technical adviser or assessor to guide him in the often intricate technicalities of an invention. The Press ought to urge this point very strongly.

Rule 10 is objectionable if it is to be so interpreted that the reference to the alleged anticipation, and which is to be inserted after the claims, is to be insisted on, even if the body of the specification already contains a distinct reference thereto, together with explanations setting forth the differences which the inventor thinks exists between his invention and the alleged anticipation. Or liberty should be given to insert the explanations after the officially inserted reference.

T. JENSEN, Chartered Patent Agent.

December 17th.

BACTERIAL PURIFICATION OF SEWAGE.

SIR,—Referring to your reprint of Dr. Reid's report on the working of the new biological filter beds at Hanley, in Staffordshire, it will be of interest to many of your readers to know that the results obtained, which are in every way most satisfactory except as regards the small quantity of oxidised nitrogen in the effluents, are strictly referable to the Hanley sewage, and that they do not necessarily apply to any other.

On the strength of the remarkable results obtained, the following experiment was made with the sewage testing apparatus at Staines, which has already been explained and illustrated in THE ENGINEER:—The filtering material which was being tested consisted of local gravel, gauged to pass 1¼in. mesh and rejected by ¼in. mesh. The results obtained, at a rate of flow of 1,000,000 gallons per acre per 24 hours, with a period between each discharge of seven minutes, were very satisfactory. In order to try the effect of smaller material, the top foot of the material being tested was removed, and a foot of the same local gravel was substituted, gauged to pass ¼in. mesh and be rejected by ⅛in. mesh.

The result was that, in the course of about ten days, a gelatinous growth began to spread itself over the surface of the filter, and the discharge from every vertical foot of the material from one to six rapidly deteriorated. The effluents became charged with a thick brown flocculent growth, that persisted after the filter had been carefully washed, and an increase of the air supply did not seem to affect it in any way. This state of things went on even after a change was made from raw strained sewage to the effluent taken from the tank, where the sewage had been treated by chemicals, and a considerable amount of septic fermentation as well. It is almost unnecessary to say that the biological character of the filter had been greatly altered by this apparently very slight change in the conditions, which, as I have already explained, consisted of nothing but substituting 1ft. deep of gravel of the same grading that gave such excellent results at Hanley. The cause of the sudden and persistent change was traced to an intermittent discharge that occurred once a week of washings from the upper surface of sand filters through which the sewage is passed before its final discharge to the Thames.

Apparently the organisms from these washings were unable to form gelatinous growths in the larger material, where they were continually being washed away by the incoming liquid, but that they easily established themselves and got the upper hand in the upper foot of the finer gravel.

Before continuing the testing, it was necessary to renew the filtering material throughout and use it of the larger size. Since doing so there has been no further trouble, and the cost of the whole experiment amounted to only a few shillings. As it saved the costly mistake of blindly following the Hanley results, which, I daresay, many engineers are now doing with the approval of the Local Government Board, it is more difficult to estimate the saving.

I send you this information as a warning against taking the results obtained from one sewage as applicable to another.

I am writing from memory, but the records of the experiment are at the works at the Staines outfall, and I have no doubt that Mr. Hall, the manager, will be very pleased to give particulars. The examination of the effluents which led to the cause of the deterioration being traced to the washings was made at the R.A.M.C. Laboratory. W. D. SCOTT-MONCRIEFF.

December 14th.

INDUCED DRAUGHT.

SIR,—I should like to be allowed to point out that your reply to "J. J. M. W.," on this subject, is far from being correct. You say, "These fans are liable to rapid destruction by heat, sulphur fumes, and dust, &c."

(1) Chemical action takes place only in the presence of heat and water. You have plenty of heat in the gases, but no moisture, and, therefore, no chemical action on the iron can take place. If we consider the original air for the draught to have been 60 deg. Fah., and containing 90 per cent. of saturation, equal to 5·2 grains of water to the cubic foot, the gases at 400 deg. Fah. will contain the same amount of moisture, but the percentage would run into the third or fourth place of decimals.

(2) Sulphur in coal averages from ½ to 1½ per cent. only.

(3) I have had these fans driven by direct connected steam engines running for as long as twelve years, and to all appearance they look as good as new.

(4) Air at 60 deg. Fah. with 90 per cent. of moisture will do infinitely more harm to the fan than the same air at 400 deg. Fah., and I have also hundreds at work on the low temperatures.

With respect to the size and speed of the fans, I greatly differ from you. To get a sufficient supply of oxygen for combustion you must have a draught of at least 1in. water gauge, and this at, say, 400 deg. Fah., would mean a periphery speed of the fan wheel of 6500ft. per minute. To effect this at 300 revolutions per minute you would require a wheel 7ft. diameter, and a case 12ft. high. I should never think of running a fan less than 500 revolutions per minute, and at this speed a fan wheel of 4½ft. diameter, and a case 7½ft. high, would be quite large enough.

There are many things that may lead a man astray in this "induced draught" question, but your correspondent will be in safe hands if he communicates with PHILIP PARSONS.

Blackburn, December 17th.

THE ADHESION OF STEAM WAGON WHEELS.

SIR,—Replying to Messrs. Thornycroft's letter of the 30th ult. re the above, it is perhaps not fair to cast all the blame of the matter upon the steam wagon manufacturers, as they cannot alter regulations. But my case is this. The firm whom we purchased our steam wagon from were asked before the order was placed whether there would be any trouble in snowy weather. They distinctly and decidedly answered "No." My firm were somewhat sceptical, so we ventured on one wagon only, with the result that when there is snow more than an inch deep, either dry and hard with frost or in a half-thawed state, our wagon with smooth-tired wheels—recommended by the makers—is helpless, and does not leave the yard, while the horses do. Snow in any state seems to incapacitate the wagon; even if there is a heavy hoar frost, we have to wait until it thaws.

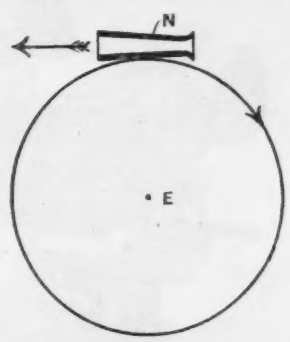
The statement of Messrs. Thornycroft's that, "with the amount of snow we usually get in England, we do not think that, on the whole, the question is such a serious one, though it may appear so to the owners at the moment," is such an extraordinary one that it leads one to suspect that they are wilfully blinding their eyes to facts. Let me state a case. A brewery company has one hundred horses. It is decided to use self-propelled vehicles for depôt and long and medium distance work. Therefore, sixty horses are sold and ten wagons purchased. During the two weeks before Christmas—one of the brewer's busiest times—there is a succession of snowstorms, thaws, and frosts. What is the brewer to do? Approach the railway company, who, well knowing it has been made a convenience of, probably deliver the stuff anyhow and at any time, or perhaps, being too busy, refuse to take the goods at all? Hire horses, when every haulier has more work than he can cope with? or shut up half the brewery? I await Messrs. Thornycroft's solution of this difficulty with curiosity, especially so when I state that the makers of our wagon have nothing, and know of nothing, either wheels or snow shoes, that they will guarantee will keep the wagon on the road in all weathers—in reason. Therefore we invest in no more self-propelled vehicles until this problem has been solved.

Messrs. Thornycroft are quite correct. "It should be considered a special circumstance when the road conditions are so bad that the wagons cannot go out." It will be a special circumstance if, after an admission of this sort, buyers purchase steam or other motor wagons, which are unreliable as to running in the winter, when our four-footed friend goes on much the same as usual, whatever the climatic conditions may be. It makes one almost inclined to parody our friend Max O'Rell, and say: "It is a fine day; let us run our steam wagon." ALF.

Wolverhampton, December 21st.

DIVERGING NOZZLES.

SIR,—I gave the expression for the reactive thrust, due to the escape of steam from a backwardly-moving diverging nozzle, as $m(V-v)$, where m = mass of steam passing through nozzle per second, V = mean velocity of steam leaving nozzle relatively to nozzle, and v = mean velocity of steam entering nozzle relatively to nozzle. I said that this expression was unaffected by any velocity which the nozzle might have. "Testor" questions this statement in the case in which $V = 0$, and in which the velocity of the nozzle = 5000ft. per second. Well, in this case v is obviously (-5000), and the reactive thrust (for m units of mass of steam per second) is $m[0-(-5000)]$; that is, $5000\,m$. It should be noted that we are not speaking of what forces have given the nozzle its



backward velocity of 5000ft. per second. This point has not been raised.

The case of the gun that I cited is, I think, a perfectly parallel example. In the sketch I give below N can represent either the nozzle or the gun; and E can represent either the earth, or the wheel, or other rotating body, on which the nozzle is mounted. The steam or the projectile, as the case may be, will have an initial velocity equal to that of that part of the wheel or earth on which it is mounted.

I fail to see how the law of the conservation of energy is run foul of. I have already ventured an opinion as to how the thrust is received. R. M. NEILSON.

30, Cross-street, Manchester,
December 19th.

HOT BRASSES.

SIR,—There are some general principles which may aid your correspondent with regard to the heating of the loose pulley bushes. When a loose pulley revolves the oil is carried round better than when the shaft revolves. As the slackness of the bush allows the oil to gather at the bottom, the oil is carried round, aided by the centrifugal force, into the arc of contact at the top of the shaft. Slight inequalities of balance and of movement through the running of the belt favours the oil entering into the arc of contact at the top of the bush when the pulley revolves. And the belt tension is evidently not sufficiently relieved by the different diameters of pulleys in the case mentioned. As the bush is in two parts the tendency of the oil will be to collect in the space between the bushes, and if sufficient collects it may ultimately run out at the ends without touching the shaft, should there be much clearance between the bush and shaft. A bush all the length of the pulley eye would both relieve the pressure on the arc of contact and favour the shaft taking up the oil as it revolves.

Sometimes, owing to want of balance or other causes, a loose pulley tends to come to rest in a certain position—the shaft wearing a certain part of the bush, so that the oil does not readily enter. Grease lubricators in such cases are unsatisfactory. Instead of the solid lubricant preventing heat, it requires heat to melt it. If at the top, the fit may be so close that the lubricant cannot enter. The spring type with soft grease is better than the screw-down type for such cases as the one in question. A loose pulley which gave me trouble I cured by putting lubricators at right angles to each other, and ordering the pulley to be stopped, so that one was at the top and the other at the side—the running-in side—of the shaft.

An oil groove with rounded edges should be cut in the bush so as to allow the oil to spread.

BEECHWOOD.

CHEAP STEAM PRODUCTION.

SIR,—Some years ago we attached forced draught and special fire bars to our two Lancashire boilers with the object of burning coke dust. The load has grown, and last week I had the water and fuel carefully checked, with the following results:—

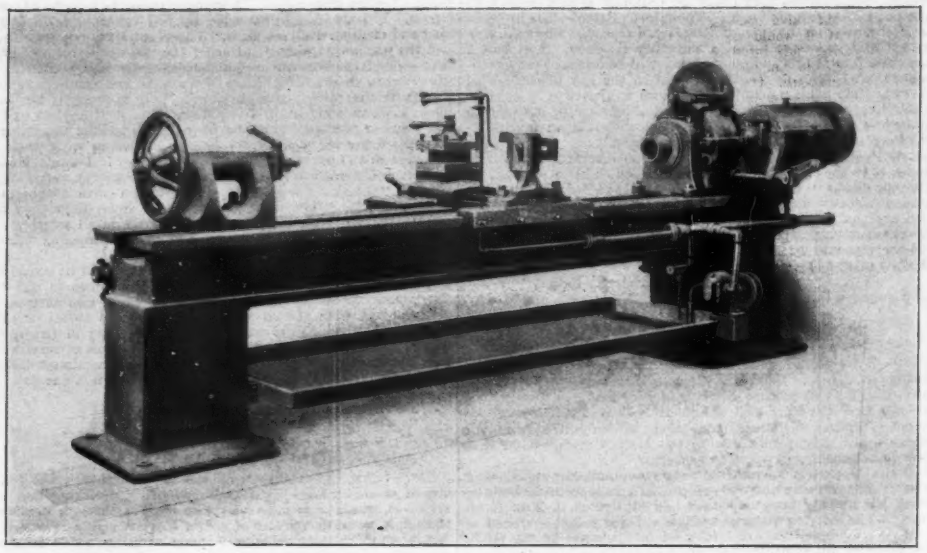
Water used in boilers from December 9th to 16th, as per Corporation meter	79,300 gallons.	
Fuel used from December 9th to 16th—		
Coke dust, 41 tons 4 cwt at 1s. 11d.	£3	19 0
Washed slack, 15 tons 17 cwt. at 6s. 6d.	£5	3 2
	£9	2 2

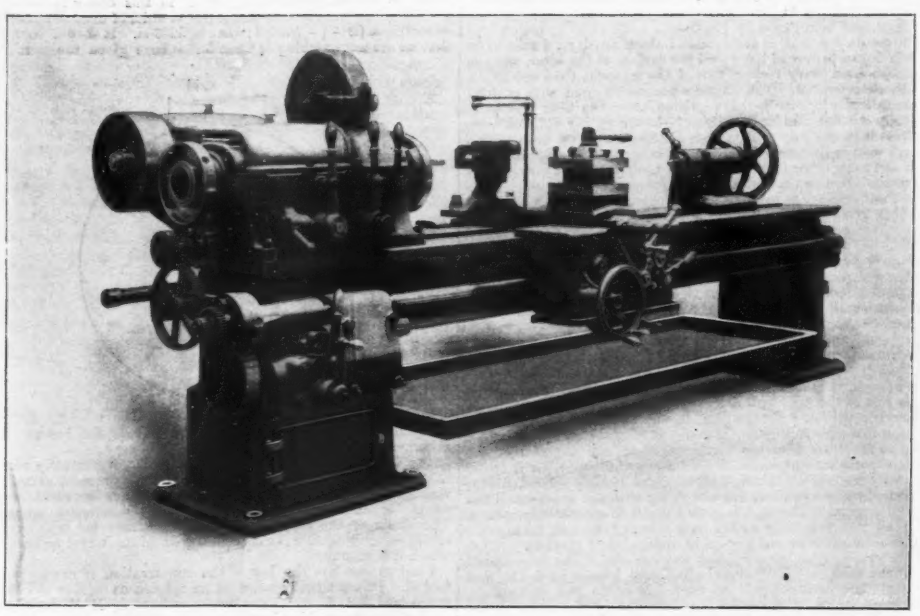
This works out at a fraction under 2s. 4d. per thousand gallons. Can this result be beaten? I may add that the water feed to the boilers is heated by the exhaust steam from the engines to 200 deg. C. D. LENG.

Sheffield, December 19th.

8½-INCH HIGH-SPEED CAPSTAN LATHE

TANGYE TOOL AND ELECTRIC COMPANY LIMITED, BIRMINGHAM, ENGINEERS





8¼-INCH CAPSTAN LATHE.

We illustrate by two views on this page an 8¼in. high-speed lathe made by the Tangye Tool and Electric Company, Limited, of Birmingham. The headstock has, it is claimed, from two to three times the power of an ordinary lathe headstock of similar size, and can be driven from a two-speed countershaft or by variable speed electric motor. It can also be changed from countershaft drive to electric drive at any time without delay or alteration. The steel spindle is 5⅛in. diameter in the front bearing, bored out to take bars up to 3⅜in. diameter. It is driven through several changes of gearing from a single pulley carried on a shaft at the back. This pulley is 14in. diameter, and takes a 4in. belt running at a high speed, thus ensuring ample power. By using this back shaft the pull of the belt and the high frictional velocity of the pulley bearing on a large diameter spindle are avoided.

The pulley is connected to a double friction clutch, which can be put into gear with either of the two wheels on the pulley shaft, or by placing the clutch lever in the central position the spindle may be stopped. There is a second gear shaft below driving in turn on to the spindle gears, which are connected by strong clutches moved from a handle in front of the headstock. There is also a double gear on the top of the headstock put in or out by an excentric shaft, which gives a maximum purchase of 40 to 1, and with a simple two-speed countershaft gives sixteen speeds to the lathe spindle, equally divided throughout the whole range, giving on the different gears 400, 305, 237, 180, 139, 106, 82·4, 62, 49, 37·3, 29, 22, 17, 13, 10 and 7·7 revolutions per minute.

All the gear is quite covered in, so that the workman cannot be caught in the wheels, and the risk of cuttings getting into the gears and breaking the teeth is avoided. The cover for the quicker running gears and clutches is only light and held on by two small bolts, so that it can be quickly taken off at any time for oiling, &c.

The bed is 19in. across the vees by 10½in. deep; it is mounted upon two box feet which have doors, and can be used as cupboards. The saddle has screw-cutting motion from a guide screw used only for that purpose, and self-acting sliding and surfacing motions from a shaft at the front of the lathe. Six changes of feeds are provided, driven by belt from the fast headstock reversing gear, with a gear-box in front. The changes of feed can be instantly made by two handles at the front, and are arranged for $\frac{1}{5}$in., $\frac{1}{7\frac{1}{2}}$in., $\frac{1}{10}$in., $\frac{1}{12\frac{1}{2}}$in., $\frac{1}{15}$in., and $\frac{1}{17\frac{1}{2}}$in. traverse per revolution. The whole of the feed gear is carried in a double apron on the saddle which covers the wheels and protects them from chips. The sliding and surfacing motions are connected by friction clutches, but a "drop-out" worm gear is also provided, so that automatic stop motion can be fitted if required. The capstan is arranged for four tools, and is made of forged steel specially heavy to avoid any springing under cut. A pump with sliding pipes and a large tray for cuttings are provided, so that a copious supply of suds or oil can be delivered to the cutting tools. There is, it will be seen, a strong resemblance between this lathe and the 12½in. lathe by the same makers illustrated in our recent Machine Tool Supplement, where a picture of the headstock gearing and a diagram of the changes was given.

A BAD CASE OF DISCHARGE OF WATER WITH STEAM FROM WATER-TUBE BOILERS: CAUSE AND REMEDIES.*

(*Concluded from page* 605.)

By A. Bement, Chicago, Ill. (Member of the Society).

Effects of Draughts of Steam on Priming.

With an engine cutting off steam, for example, at one-quarter stroke, it will, during the interval that the valve is open, take steam at a rate four times faster than it is being generated; such steam is in storage in the piping and boiler drums, and with each valve opening the steam pressure will be reduced, with the result that the rate of evaporation in the boilers will be increased for the interval of drop, in proportion to the amount of drop in pressure occurring in the boilers. The steam pressure employed in the plant in question is 175 lb. above atmosphere; at this temperature a drop of 1 lb. pressure will liberate approximately 0·5 of a heat unit for each pound of water in the boilers, therefore a small fraction of 1 lb. drop in pressure, if occurring in sufficiently short interval, would increase the rate of evaporation to an amount enormously greater than the average, and to this is due the trouble from water in engines K and L, as compared with others in the plant.

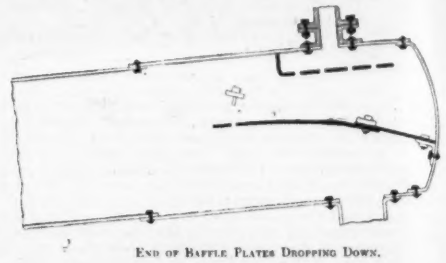
If steam storage capacity is compared with demand made upon it, useful facts are presented. Referring to Fig. 1, engines A, B, and C and boilers Nos. 2, 4, 6, and 8 are designated group No. 1. Engines D and E and boilers Nos. 10 and 12 compose group No. 2; group No. 3 includes engines K and L and boilers Nos. 14, 16, 18, 20, 22, and 24. In calculating steam storage volume for these three groups, the cubic contents of the main steam header and engine connections are taken. It is, of course, true that steam is in storage in much other piping, but it cannot respond to the sudden demand to any large extent, because of the brief interval of time. For this reason drop in steam pressure occurs particularly in the boilers composing these groups, owing to their respective engines drawing more directly from them. A large amount of storage space exists in the boiler drums, of course, but this is relatively equal in each group.

* American Society of Mechanical Engineers, New York meeting.

Table A.—*Steam Storage Space Compared with Kilowatt Capacity.*

Engines and boilers—Group number.	Kilowatts.	Relative number of valve openings in given interval.	Cubic feet of storage.	Kilowatts per cubic foot of storage space.	Relative demand made on steam storage space. Group No. 1 the standard.
1	1760	1·73	110	16·00	1·00
2	1760	1·46	76	23·11	2·49
3—Original	7750	1·00	183	42·35	7·92
3—Small separators .. .	7750	1·00	223	34·75	6·50
3—Large separators .. .	7750	1·00	647	11·96	2·23

Table A shows the relations of the groups in reference to kilowatt output per cubic foot of storage space. The relation in group No. 3 is given as the engines were originally installed without separators, also with the small separators, and with still larger ones now in use. Engines A and B run at 150 revolutions per minute, C at 90 and D and E at 110 revolutions, while engines K and L make 75 revolutions per minute. Therefore these larger engines which make less number of revolutions in a given time, must take proportionately more steam at each valve opening, for this reason draw harder on the stored supply of steam, with the result that drop in pressure in the boilers of group No. 3 is in proportion. The figures in the last column of the table are prepared in accordance with this fact.



End of Baffle Plates Dropping Down.

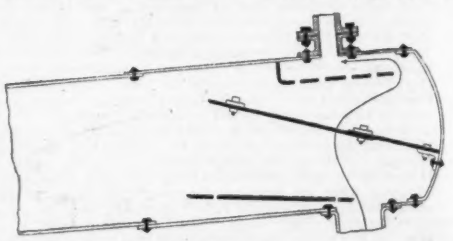
Fig. 16

Calorimetric tests for moisture in steam from boilers of group No. 3, and measurements for drop in pressure at engine K, in steam header of group No. 3, also in steam header of group No. 1, were made during the time that the small separators on engine K and L were in service. The results of these experiments will follow.

Table B.—*Change in Steam Pressure, due to Engines taking Steam, Average Conditions.*

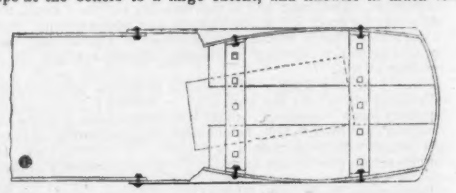
Location of measurements.	Variation in pressure. lb.	Drop in pressure. lb.
At the throttle of engine K	25·0 ..	16·25
Steam header group No. 3 at A—Fig. 15	11·0 ..	5·5
" " " " B	8·0 ..	4·0
" pipe from boiler No. 14	1·0 ..	—
" header at engine C of group No. 1	4·0 ..	2·0

The pressure measurements given in Table B were made with a Crosby steam engine indicator, using a 100 lb. spring. Location of these measurements were on the steam header near boilers Nos. 13 to 16. The measurement in the steam header of group No. 1, at the outlet to engine C, corresponded in location to similar measurements in the header of group No. 3. The change of pressure in the steam pipe at boiler No. 14, as near as the diagram could be measured, appeared to be 1 lb., which could, however, be assumed to be even less. It is impossible, in fact, to measure the drop in pressure in the boiler drums, because there can be no drop, for the reason that the liberation of latent heat results in evaporation of water, and the resulting steam immediately tends to restore the pressure. This action influences the pressure in the steam pipe at the boilers to a large extent, and likewise in much less measure affects the drop in the header. Therefore, there is no drop in pressure in the boilers, but there is increased evaporation. There would, of course, be an extremely small amount of lag in the response of the evaporation in restoring the steam removed, and this, if anything, is what could be measured in the steam pipe at the boiler.



Elevation. Plate Completely Detached.

Fig. 17



Plan. Plate Completely Detached.

Fig. 18

Upon the opening of a steam valve pressure would drop, and steam flow to the cylinder at considerable velocity; at valve closure this flow would suddenly be arrested, resulting in the

inertia raising the pressure in the piping, which would, of course, fall to normal before the valve opened again. Therefore, the variation in pressures given in Table B are both drop and surge, between which the indicator does not distinguish. For this reason a Bristol recording gauge was attached to the same point with the indicator, the change of pressure making a record on the moving chart. When this was obtained the gauge cock was throttled, so that the pressure in the gauge was contant; then the resulting record gave evidence of how much of the change was due to drop below normal and that due to surge above normal. Thus figures for the last column of Table B were obtained.

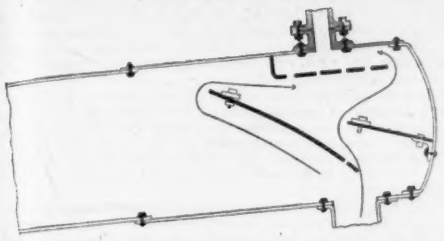
A very interesting proof that there is a surge, was afforded by experiments with the steam calorimeter. Its location was as much as 8ft. away from the point where the cylinder oil entered, yet oil was carried back and entered the calorimeter, resting on the water as shown in the glass gauge.

At the opening of steam valves, pressure drops and rate of evaporation in the boilers increases. At valve closure the flow is arrested, resulting in pressure in the piping being raised above normal, causing a return surge to the boilers, raising the pressure therein and stopping evaporation entirely for a brief interval.

Thus the performance in the boilers is divided into three periods; a very high peak of evaporation, followed by a brief interval of no evaporation at all, and then a longer period of evaporation at normal rate, the average rate being in proportion to the absorption of heat by the boilers. It is these peaks of evaporation which cause the water, or most of it, to be carried over the standard baffles, thence out with the steam to the engines.

Effect of Water-hammer on Baffles.

The foregoing discussion of the performance of the process of evaporation, while being correct, offers no corroborative evidence. It is therefore in order to submit proof of the fact. If the engines



Exceptionally Dangerous Failure in Boiler No. 16.

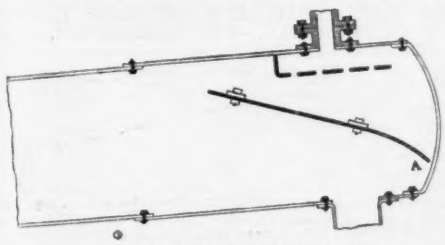
Fig. 19

and boilers of group No. 3 were a unit, it would be possible to calculate the effect of drop in pressure, and express the result in rate of evaporation, but this group is connected, not only with an equal number of boilers on the opposite side of the room, but with the other portion of the plant by means of a 9in. equaliser. For this reason stored steam in these portions has an unknown influence on the problem. That such influence is not large, however, will be shown. Reference to Fig. 2 will illustrate the construction of the standard water baffles as furnished in boilers Nos. 15 to 24. As observed they are composed of six pieces of steel plates $\frac{5}{16}$in. thick, bolted to the two traverse braces, the baffle being made up in the width of three pieces, and in length of two pieces, those in contact with the head of the drum being attached to it.

With every one of these baffles in the drums of the boilers of group No. 3 failure has occurred by nuts becoming unscrewed and dropping off, causing the plates to become detached so that, to a greater or less extent every baffle has come to pieces. Examples of these failures are illustrated in Figs. 16 to 18.

Fig. 16 is an example of the most common failure, and consisted in the nuts coming off and allowing the upper end of the plates to drop down. There is no evidence that this kind of failure increased the moisture in the steam; it probably had an opposite effect, because in a measure it acted similar to the middle form of baffle tested in the model boiler.

Fig. 19 illustrates a very bad failure, as it allowed water to rise directly above the baffle, filling the space so that the steam passing over the end carried it out in large mass. This failure occurred in boiler No. 16, and was immediately followed by a great rush of



Old Style Baffle. Boiler No. 14.

Fig. 20

water to engine K, which squirted out of the high-pressure cylinder head joints, raised the shaft, stretched the studs, and destroyed the gasket under the cylinder head. The next Sunday, when permanent repairs were attempted, it was discovered that the cylinder was cracked in the fillet of the flange. This was the most serious rush of the water entering either of these engines; it produced a tremendous upheaval which shook the building, with only the damage described, which serves to indicate that a large amount of water may pass through an engine without causing much damage.

The baffles in other of the eighteen boilers under discussion in this plant are secured with bolts just the same as are these six, but have never unscrewed and released a plate, although some of them have been in service a period four times as long as those of group No. 3. With the boilers on the opposite side of the room there has been no trouble of this character, although made and installed at the same time, and discharged to the same steam header. These failures can only be accounted for by the peaks of evaporation, the force of the rising water unscrewing the nuts from the bolts. Recurrence of these failures was prevented by riveting the end of the bolts over the nuts.

Another exceptionally strong proof of the occurrence of these peaks of evaporation is afforded by Fig. 20, showing the old style of baffle in boiler No. 14, which is composed of three pieces of plate of full length, but not attached to the head of the drum, being loose, as shown at A. With each opening of high-pressure steam valves of engine K it strikes a blow against the head at A, but with engines K and L out of service, and the boiler at maximum capacity, there are no blows. Likewise similar baffles in boiler No. 12 of group No. 2, where the steam storage space is not large, strike a similar blow, but not near so hard. But with other similar baffles in other portions of the plant there is no sound. The behaviour of these baffles not only show that drop in pressure has a serious effect on the boilers of group No. 3, but that it does not extend to any great extent to those on the other side of the room.

If it is assumed that there was no hot water in the boilers, but the storage space filled with steam, then opening of a steam valve would cause a reduction of pressure. With the water present there is no actual drop in the boiler drums, but there occurs what may be termed a theoretical drop, which, if being known, makes it possible to calculate the rate of evaporation. But for reasons before mentioned, this is not known. Therefore it is assumed that the average theoretical drop in the boilers of this group was 0·15 lb., which occurring for a period of 0·1 of a second, corresponding to the valve opening at 75 revolutions per minute, at one quarter cut-off, would result in the evaporation of 2·3292 lb. of water during this interval. At the rate of 23·292 lb. per second, or 83,851 lb. per hour, equal to 2430 horse-power from one boiler. The contents of a boiler being 30,000 lb. of water, and the liberation of heat equal to 0·5 British thermal unit from each pound for a drop of 1 lb. pressure. At the beginning of valve opening the flow of steam is slow reaching maximum at closure, when the return surge to the boilers raises the pressure and stops evaporation entirely. Fig. 21 is a graphic illustration of this performance, wherein the peaks are reduced to a mere fraction of 0·1 of a second

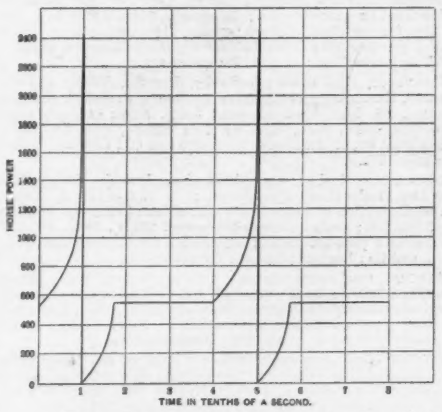
Calorimetric Determinations.

The usual method employed to determine whether boilers are discharging wet steam is to test it with a calorimeter. One hundred and forty-three such tests were made on boilers of Group No. 3, the results of which are most interesting, and prove the utter fallacy of this business as far as getting an average sample is concerned. It is the author's opinion that the water in a vertical pipe will flow in contact with the walls; for this reason, a sample taken from the centre of the pipe cannot show an average percentage of water. For this reason, the sampling pipes, which were duplicates of each other, were perforated for their whole length, so that, if possible, the sample would be gathered uniformly from the centre to surface of the pipe, with the idea of securing any water travelling along the pipe. The 0·5in. pipes were each bushed with a 0·25in. pipe, and twenty $\frac{1}{16}$in. holes drilled through each, and the inner ends of the sampling pipes were plugged. A Carpenter separating calorimeter was used.

It is a fact that the harder a boiler is worked the more water it will discharge with the steam, but the most significant showing of the moisture determination was the presentation of the results as being just the opposite. For example, tests were made on boiler No. 22 under different conditions, with the following results:—

Conditions.	Range of moisture per cent.
Engine L only in service, boiler at small capacity	11·56 to 17·72
Engine L only in service, boiler at large capacity	7·14 to 10·96
Engines L and K in service taking steam at the same interval, and boiler at full capacity	1·66 to 2·11

Tests were made under all attainable conditions except that of high water, which was not advisable to attempt. Arrangements were made that the relative crank positions could be made the same, ensuring that these two engines took steam simultaneously. The extreme range of all samples, from all boilers and conditions,



Rate of Evaporation One Boiler, Boilers of Group No. 3 during One Revolution of Engines K and L.

Fig. 21

was from 1·37 to 23 per cent. moisture. The higher determinations were from boiler No. 18 when the baffle was in the condition shown in Figs. 17 and 18, which will be discussed later. Moisture with everything in normal condition ranged from 1·37 to 17·72 per cent.

The probable explanation for the various samples obtained from boiler No. 22, for example, under the different conditions of operation, is a difference in velocity of steam flowing from the boiler. For illustration, the outlet from the calorimeter does not exceed $\frac{1}{16}$ of an inch in diameter, while the inlet at the sampling pipe is many times greater. For this reason, the velocity of flow of the steam into it is not high; therefore, when steam flows from the boiler at high velocity, the water is carried past the sampling pipe, but when flowing from the boiler at low velocity the calorimeter gathers more water, so that when the sample showed 17 per cent., for example, it contained a greater percentage of water than the steam leaving the boiler. Therefore, depending on conditions, the sample either contained too much or too little water.

During these moisture determinations all of the boilers of this third group were equipped with the standard baffle, except No. 20, which was fitted with the middle form shown in Fig. 3. The same tests were applied to it as to No. 22, except that the water line was as much as 6in. higher. The comparison between the baffles is:—

Baffles.	Range of moisture per cent.
Standard baffle, boiler No. 22	1·66 to 17·72
Middle baffle, boiler No. 20	1·51 to 2·11

The tests on boiler No. 20 with the middle form of baffle would indicate that it produced much drier steam than the standard, as proven by the tests in the experimental boiler. But with it most moisture was present in the sample at low capacity, but as the condition which produced 2·11 per cent. with this baffle, made 17·72 per cent. with the other, may be taken to mean that it produced drier steam, as the experimental boiler showed it should do. Yet this 2·11 per cent. moisture was greater than an average sample would have given.

Another phase of the matter was shown by tests on boiler No. 18, when one of the baffles was in the condition shown in Figs. 17 and 18. Tests were made while in this condition and after repairs. Corresponding tests were also made at the throttle valve of engine K. The results were as follows:—

Condition of baffle.	Range of moisture per cent. Different conditions of operation. Boiler No. 18.	Engine K.
Imperfect	3·84 to 23·53 ..	5·80 to 12·18
Perfect..	1·66 to 5·80 ..	2·25 to 2·99

The sampling pipe did not extend into the main, the sample being gathered from the upper surface. From these samples it is not to be inferred that moisture entering engine K was as low as 2·25 per cent. But these records, compared with those from boiler No. 22, would indicate that if there was moisture enough present, it would enter the calorimeter even with the flow of steam at high velocity.

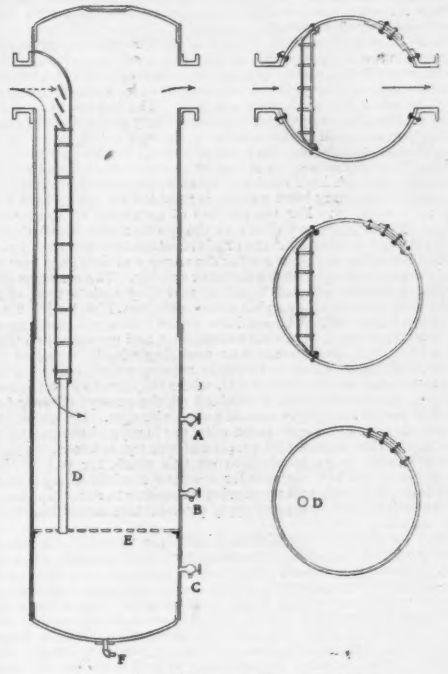
Samples from the centre of the steam pipe from boiler No. 14, taken under different conditions, range from 1·66 to 3·04 per cent. moisture. This and No. 16 are the ones most affected by the drop in pressure.

Performance of Large Separators.

The above experiments and tests were made when the small separators were in use. Since that time very much larger ones, measuring 4ft. diameter by 17ft. long, of a unique design, have replaced them, which are shown in section by Fig. 22, the upper portion being divided into two parts by a hollow partition, making the area of the inlet side very small, while the outlet side is very much larger. As shown, there is an opening at the top of the partition, fitted with metal plates at an angle. It would appear that the operation of this device is based on the asumption that the water would leave the rapidly-moving steam, and flow directly into the top of the partition, from which it would pass by way of the 2in pipe D to the chamber at the bottom, below the perforated partition E. For this to occur, however, would require that separation takes place in a much smaller space than was afforded by the small separators, which were themselves too small; therefore it necessarily follows that the entering water must continue with the steam through the inlet passage, into the large volume of the outlet side, where separation would occur if reduction of velocity be sufficient. To determine whether separation was effected, gauge cocks A and B from the locality of assumed dry steam was opened, with the result that the escape of water and steam alternated each other. But from cock C, leading from the water chamber, dry steam issued continually. It is probable that if these separators had been so connected that the steam enter what is now the outlet, the result would have been better, because if the velocity in the large chamber should be low enough to allow of separation it would be more readily attained in a downward flow.

The indications to the present time are that all of the water entering these separators leaves again with the steam. But owing to their large volume effective steam storage space is very much increased, and for this reason less water leaves the boilers, their installation being a partial remedy only.

For water to separate from moving steam requires that the velocity be sufficiently low for it to occur, and if the quantity of steam be great, it necessitates an inconveniently large space. Therefore it is better to accomplish separation at the boilers,



Large Separators Engines K and L.

Fig. 22

where in this case it could be divided up among the twenty-four boiler drums, with the added advantage that the water does not require to be returned to them. This the high form of baffle, with deflectors, would accomplish in a most satisfactory manner.

Physical Society.—At a meeting of the Physical Society held on December 8th, a paper on "A High Frequency Alternator" was read by Mr. W. Duddell. The author described and showed in action a high-frequency alternator, which he had constructed in 1900 for some experiments on the resistance of the electric arc, and with which frequencies up to 120,000 alternations per second had been obtained. The alternator consists of an inductor, built up out of ferrotype plate, having V-shaped notches cut in its edge so as to have flat-topped teeth. Surrounding the inductor is a laminated ring having two inwardly projecting poles, the clearance between these and the teeth of the inductor which formed the air gap being less than 0·1 mm. The ring is wound so that a direct current flowing round the winding tends to produce lines of force from one pole to the other through the inductor. The number of lines of force varies from a maximum when the teeth of the inductor are opposite the poles, to a minimum when the poles are in front of the spaces. This variation in the total number of lines of force produces alternating E.M.F.'s in any winding, either on the pole pieces or on the ring itself; the movement of the inductor through the distance between two consecutive teeth producing one complete period. One winding on the ring could serve to carry both the direct field current which magnetises the ring and the alternating current produced. In practice, owing to the great importance of any self-induction in the alternate-current circuit, it was found advisable at high frequencies to use separate windings for the two currents. At the highest frequencies the best results were obtained with coils having a few turns of wire fixed right on the tips of the poles. The alternator is driven by means of a figure-of-8 belt drive from two phosphor-bronze discs. Each of these discs is belted to a double-grooved pulley fixed on the shaft of a direct-current driving motor. With this method of drive the inductor was run for several months at speeds between 30,000 and 40,000 revolutions per minute, and the spindle of the inductor alone could be easily run at 60,000 revolutions per minute. Using inductors having 30, 60, 90, and 204 teeth, the author obtains small alternating currents having frequencies from a few hundred periods per second up to 120,000 alternations per second. An illustration will perhaps convey some idea of how high a frequency of 120,000 alternations per second really is. In plotting curves for ordinary frequencies of 50 to 100 alternations per second, a scale often adopted is 10in. for 100 alternations. If it were attempted to plot a curve up to 120,000 alternations per second to this scale, the curve paper would require to be 120,000in., or nearly one-fifth of a mile long.

THE JUNIOR INSTITUTION OF ENGINEERS.

With the permission of the managing director, Mr. Oswald Stoll, the London Coliseum was recently opened to the visit of this Institution for the inspection of its many features of engineering interest. The visitors attending numbered over 250, and were received by Mr. Wingfield Bowles, under whose supervision the work has been carried out. Mr. E. Eade and Mr. W. J. Boutell were present on behalf of Messrs. Ransomes and Rapier, contractors for the revolving stages, panorama gear, travelling carriages, winches, &c. The stages are three in number, arranged in concentric rings, the outer one being 75ft. diameter, intermediate 50ft., and the central one 25ft. Each is mounted independently upon a ring of carrying wheels, some of which are driven by electric motors, operated by a novel arrangement of controllers by which ten varying speeds are obtainable, the highest speed being equivalent to about 20 miles per hour on the outer table. The stages can be run in either direction, either separately or all together. Horizontal rollers are also provided to keep the tables concentric. The motors and resistances are so arranged that the number in operation can be varied, and in case of breakdown the faulty motors can be cut out and the work performed by the remainder. Complete control is ensured by means of both electric and mechanical brakes, the latter being operated by hydraulic power, so that the tables can be brought to rest very quickly. Each table will carry a moving load of 11 tons in addition to its own weight, so that the total mass that can be set in motion is about 150 tons. The tables are operated from a gallery on the prompt side of the stage, a separate operator manipulating each table. On this controller gallery is fixed an indicator board, fitted with instruments recording the current and hydraulic pressure, also ships' telegraphs, indicating instructions given from the stage level. The controllers and resistances are in rooms below the stage, and are operated from the controller gallery by means of worm gears mounted on cast iron pillars. On the tops of the pillars are fixed brass discs of large diameter, with the various positions of the controller steps clearly marked out, so that possibility of error in working is reduced to a minimum.

The panorama gear consists of the following:—Three power-driven rollers for ordinary panoramas, four sets of hand-driven rollers for ordinary panoramas, and one set of two-power driven rollers for cyclorama or circular panorama, together with the necessary grooves, crossing the stage.

In crossing from one side of the stage to the other the cloths are hung from a wire rope, which winds on to or off the rollers at the same time as the cloths themselves. The ropes run in grooves, suspended from the grid, and are supported by a special form of clip, to which the cloths are attached. The lengths of groove between the flies carrying the three ordinary power-driven panoramas are arranged to lift vertically through a height of 12ft., special winches being provided in the O.P. fly for the purpose.

The five power rollers are driven by electric motors placed under the stage through high efficiency silent worm gearing enclosed in oil baths. Auxiliary hand gearing is provided on the fly floor for use as a stand-by. For the purpose of gathering up the three-power driven panorama cloths in the prompt side scene dock, walking ways of light steel are provided, suspended from the fly.

The travelling carriages are for the purpose of bringing people and scenery into sight of the audience quickly. The carriages are three in number, coupled together, and they each consist of a light steel framework, carrying a teak platform, 17ft. by 4ft. 6in., at about stage level. The carriages depend from and travel upon a girder fixed about 40ft. above stage level, and crossing from side to side. Each carriage has four travelling wheels, arranged in pairs in a bogie frame, to facilitate running round a curve into the scene dock on the prompt side, where they are kept when not in use. An electric winch is provided on the prompt side fly for driving the carriages by means of a steel wire rope. The maximum speed of the carriages is seven miles per hour, and the weight of the three, when loaded with people and scenery, is 8 tons.

An electric brake is provided on this winch for pulling the carriages up quickly, but in order to ensure absolute safety should this brake fail to act and the carriages continue to run, they themselves cut off the current and apply powerful mechanical brakes to the travelling wheels.

Two sets of five power-driven winches are provided, one set on the fly floor of each side of the stage, for lifting wrought cages in which scenery is placed. Each set is arranged in a line, each winch having three barrels coiling ropes which pass from the top of the cages over pulleys fixed on to the grid. The winches are arranged so that they can be driven from an electric motor, two at a time, or they can be driven independently, clutches being provided for putting into or out of gear any particular winch. An electric brake is fitted to the motor to pull it up quickly after the current has been cut off; also each winch has an independent mechanical brake.

Six sets of hand-power winches for raising sky cloths, &c., have also been fixed on the fly floors, each winch being provided with three barrels coiling ropes, to which are attached steel tubes 55ft. long. The ropes are passed over pulleys fixed on the grid. Each winch also has a barrel for coiling a counter-balance rope, the counter-balance weight being arranged to work up and down in guides on the side wall of the building.

At the conclusion of the inspection the thanks of the members for the special arrangements which had been made for their reception were expressed by Mr. W. J. Tennant, past-chairman.

ALMANACS, DIARIES, &c.

Messrs. Thos. Robinson and Son, Limited, of Rochdale, have sent us a wall calendar of the tear-off pattern, the slips each containing the six working days of each week; Sundays are excluded. The design is neat, and the dates clearly printed. Henry Simon, Limited, of Manchester, adheres to the much appreciated block wall calendar with daily slips, each of which is provided with a well-chosen quotation from a recognised author. The wall calendar by Messrs. George Cradock and Co., Wakefield, is also of this firm's usual style, and has monthly tear-off slips with large, clear figures. Calvert's Mechanics' Almanack for 1905 is almost too well known to require any comment here. It has now reached its thirty-second year of publication, and is as highly appreciated as ever by the artisans and craftsmen for whom it is chiefly intended. Messrs. E. R. and F. Turner, Limited, Ipswich, have sent us a wall calendar of the daily block pattern with a separate quotation or saying for each day. Cochran and Co., Annan, Limited, have also published a wall calendar on which is neatly represented in colours a section of the Cochran vertical fire-tube boiler. This calendar has daily tear-off slips. Messrs. Clayton, Son and Co., Limited, Leeds, have issued a wall calendar with monthly tear-off slips. The illustration represents a gasholder, a branch of work for which this firm is noted. A wall calendar has been published by Mr. John Etherington, of King William-street, London Bridge. This is of the usual type with easily legible figures. Our latest batch of these seasonable publications includes a wall calendar from the United States Metallic Packing Company, Limited, on which is tastefully reproduced in bas-relief the seminude statue of Atalanta, by Concetto Vicari. Wall calendars of the monthly tear-off pattern from Messrs. John Rogerson and Co., Limited, and from the *Chemical Trade Journal*. Messrs. Crosier, Stephens and Co., Newcastle-on-Tyne, have issued a card on which is printed a good wish for the forthcoming year, and is accompanied by a paper knife. The wall calendar issued by Messrs. Dickson and Mann, Limited, of Armadale, Scotland, is a neat production with monthly tear-off slips.

LAUNCHES AND TRIAL TRIPS.

Clacton, steel twin-screw; built by, Earle's Shipbuilding and Engineering Company, Limited, Hull; to the order of, the Great Eastern Railway; dimensions, length 245ft., beam 31ft.; to carry, cargo; engines, twin-screw of the three-crank triple-compound type, 15½in., 25½in., and 41in., stroke 36in., pressure 180 lb.; constructed by, the builders; launch, November 28th.

Branksome Hall, steamship; built by, Swan, Hunter and Wigham Richardson, Limited; to the order of, the Ellerman Lines; dimensions, 386ft., 46ft. 8in., 30ft. 5in.; to carry, 6900 tons deadweight; engines, triple-expansion, 23½in., 40in., and 69in. by 48in.; constructed by, Wallsend Slipway and Engineering Company; a speed of 11¾ knots was attained; trial trip, November 29th.

Coquet, steel screw steamer; built by, Sir Raylton Dixon and Co., Limited; to the order of, Messrs. Glover Brothers; dimensions, 372ft., 50ft. by 28ft. 3in.; engines, triple-expansion, 25in., 42in., 68in. by 45in., pressure 180 lb.; constructed by, Blair and Co., Limited; trial trip, November 30th.

Hornsea, single-deck type steamer; built by, Blyth Shipbuilding Company, Blyth; to the order of, the Sea Steamship Company, Limited, Hull; dimensions, 343ft., 47ft. 3in. by 24ft. 5in.; to carry, grain and timber; engines, triple-expansion, 23in., 38in., and 64in. by 42in.; constructed by, North-Eastern Marine Engineering Company; the trial trip was quite satisfactory; trial trip, December 5th.

Greenbank, turret-deck steamer; built by, Messrs. Wm. Doxford and Son; to the order of, Messrs. The Horsley Line, Limited, Hartlepool; dimensions, 352ft. by 48ft. by 26ft.; launch, December 7th.

Netherton; built by, Northumberland Shipbuilding Company, Howden-on-Tyne; to the order of, John Greenlees and Co., Glasgow; dimensions, 372ft. by 48ft. by 30ft. 10in.; engines, triple-expansion, 24½in., 40in., and 68in. by 48in. stroke, pressure 180 lb.; constructed by, North-Eastern Marine Engineering Company, Limited; launch, December 7th.

Katholm; built by, Messrs. Chantier Naval Anvesois, Antwerp; to the order of, Messrs. Johnsen and Jespersen, Copenhagen; dimensions, 230ft. by 35ft. 6in. by 17ft. 3in.; engines, triple-expansion, 17in., 28in., 46in. by 30in. stroke, pressure 160 lb.; constructed by, North-Eastern Marine Engineering Company, Limited, Northumberland Engine Works; trial trip, recently.

Santona, steel screw; built by, The Tyne Iron Shipbuilding Company; to the order of, Donald and Taylor, Glasgow; dimensions, 331ft. by breadth 48ft. by moulded depth 24ft. 4½in.; engines, triple-expansion, 24in., 40in., 65in. by 42in. stroke, pressure 160 lb; constructed by, Wallsend Slipway and Engineering Company, Limited; launch, December 7th.

Abbotsford; built by, Joseph L. Thompson and Sons, Limited, Sunderland; to the order of, Messrs. Charlton and Thompson, Baltic Chambers, Sunderland; dimensions, 360ft. 3in. by 50ft. 10in. by 25ft. 6in.; engines, triple-expansion, 24½in., 40in., 66in. by 45in. stroke, pressure 180 lb.; constructed by, John Dickinson and Sons, Limited, Sunderland; launch, December 8th.

Harmonic, steel screw; built by, Furness, Withy and Co., Limited, Hartlepool; to the order of, Messrs. J. and C. Harrison, Limited, 66, Mark-lane, London; 335ft. long; engines, triple-expansion, 23in., 40in., 65in. by 42in stroke, pressure 200 lb.; constructed by, Richardsons, Westgarth and Co., Limited; launch, December 8th.

Germanic, steel screw; built by, Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of, Messrs. W. H. Cockerline and Co., Hull; dimensions, 342ft. by 49ft. 6in. by 25ft. 2in.; engines, triple-expansion, 23½in., 39in., 66in. by 45in. stroke, pressure 180 lb; constructed by, Richardsons, Westgarth and Co, Limited; launch, December 8th.

Arrival, steel screw steamer; built by, Messrs. Wood, Skinner and Co., Limited; to the order of, Mr. C. Rowbotham; to carry, 400 tons deadweight; engines, triple-expansion, 13in., 21in., 35in. by 24in., pressure 180 lb.; constructed by, North-Eastern Marine Engineering Company; trial trip, December 15th.

Filippo, steel screw cargo steamer; built by, the Northumberland Shipbuilding Company, Limited; to the order of, Mr. D. Tripcovich; dimensions, 430ft., 54ft. by 32ft. 2in.; to carry, 9000 tons deadweight; engines, triple-expansion, 27in., 45in., 74in. by 48in., pressure 180 lb.; constructed by, North-Eastern Marine Engineering Company; a speed of over 11 knots was attained; trial trip, December 15th.

Pontop, steel screw steamer; to the order of, the Pearetb Steamship Company, Limited; dimensions, 335ft. long; engines, triple-expansion, 23½in., 38in., 64in. by 42in., pressure 180 lb.; constructed by, Richardsons, Westgarth and Co.; a speed of 12 knots was attained; trial trip, December 17th.

NAVAL ENGINEER APPOINTMENTS.

The following appointments have been made at the Admiralty:—

Engineer Commanders.—R. B. Ayers, to the Firequeen, for the Pandora, on paying off; G. W. Roome, to the Firequeen, for the Prince George; J. R. Roffey, to the Pembroke, for the Ramillies; H. C. McLean, to the Pembroke, for the Anson; S. G. Haddock, to the Pembroke, for the Resolution; W. G. Mogg, to the Vivid, for the Hood; M. Sennett, to the Vivid, for the Blake; and E. Swinney, to the Vivid, for the Edgar.

Engineer Lieutenants —S. J. Drake, to the Vivid, for the Flora; R. Main, to the Vivid, for the Harrier; H. J. Leader, to the Pembroke, for the Pioneer; H. Basson, to the Pembroke, for the Pyramus; S. Ham, to the Pembroke, for the Speedy; J. A. Richards, to the Firequeen, for the Indefatigable, all on paying off; H. F. Russell, to the Vivid, for the Duke of Edinburgh; C. E. Stone, to the Revenge; E. V. Waud, to the Juno; W. A. Wilson, to the Firequeen, for the Brazen; A. E. Atkins, to the Pembroke, for the Roebuck; C. L. Warren, to the Pembroke, supernumerary; G. S. Holgate, to the Halcyon, for the Ribble; F. J. Page, to the Pembroke, for the Pegasus; and C. Broadbent, to the Vivid, for the Hussar, on paying off; W. A. Dathan, to the Fire Queen for the Surly on the Pyramus paying off; G. C. Nicolson, to the Halcyon, for the Cheerful.

Physical Society.—At a meeting of this society held on November 25th, a paper on "The Measurement of Small Differences of Phase" was read by Dr. W. E. Sumpner. The author describes new voltmeter methods which may be used, and gives the results of a number of measurements on alternating current plant. Difficulties arising in the measurement of very small alternating current voltages are overcome by rectifying the voltages so as to utilise sensitive direct-current instruments. The paper gives the result of some tests of two transformers of 3 kilowatt capacity intended to work between voltages of 100 and 1000, and with currents of 100 cycles per second. One transformer was used to step up the volts from V_1 to V_2, the other to step down from V_2 to V_3. It was found that the phase-difference between V_1 and V_3 for a non-conductive load increases regularly with the current. For an inductive load there is a sharply defined minimum at low power factor. The author suggested that points on one side of the minimum corresponded to a lag, and points on the other side to a lead of the current on the voltage in the primary circuit.

CATALOGUES.

Ferranti, Limited, Hollinwood, Lancashire.—Catalogue No. 7 describes this firm's class B current transformers, ammeters, &c.

W. H. Bailey and Co., Limited, Manchester.—List 294 is an abstract from Section 6 of Bailey's pumps and hydraulic machinery, and is devoted to the Davidson pumps.

Beanland, Perkin and Co., School Close Works, Leeds.—A sheet showing a new combined tool grinder, disc grinder, and buffing wheel, and also a hand hack saw for use on the bench.

John Whitehead and Co., Limited, Preston.—A catalogue illustrating and describing the numerous machines made by this firm for brick, tile, and pipe-making, and also clay-working, and accessories generally.

John Spencer, Limited, Wednesbury.—The twenty-second edition of the catalogue of iron and steel tubes, fittings, and tools made by this firm contains considerable information which will be serviceable to the engineer in concise form.

Graham, Morton and Co., Limited, Leeds. Catalogue No. 940. —This book describes numerous installations of conveying plant, which have been designed by this firm for handling all classes of material. The illustrations are particularly effective.

Eugen Blaxberg and Co., Düsseldorf.—This is a catalogue of condensing plants, cooling towers, and oil separators published in the German, English, and French languages. The agent in this country is Mr. John Child, 108, Claremont-road, Liverpool.

Mathews and Yates, Limited, Swinton, Manchester.—A small descriptive catalogue of the "Cyclone" high-speed forced lubrication engines. They make either single-cylinder or compound engines; the former are made in four standard sizes. The latter are made to suit the purchaser's requirements.

Bruce and Still, Limited, 49, Sefton-street, Liverpool.—A catalogue containing photographs of several structures made by this firm. The illustrations show iron and steel framed buildings, foot-bridges, and roofs, drill sheds, car sheds, and churches, &c., which they have constructed.

The Acetylene Illuminating Company, Limited, 3, Victoria-street, London.—A pamphlet giving an interesting account of the process of autogenous soldering or welding by the oxy-acetylene blow-pipe. Illustrations are given of the apparatus, and there is also a complete price list. The company is prepared to rent out the plant for trial, the rent being remitted if the apparatus is purchased.

W. E. Maulsdale and Co., 21, Chapel-street, Liverpool.—This pamphlet describes various forms of "bi-fluid" tachometers. It may be explained that the "bi-fluid" tachometer is an instrument for measuring speed of rotation or of progressive motion by utilising the difference of effect exercised by centrifugal force on two fluids of widely different specific gravity enclosed in a tube and specially-constructed reservoir. The tachometer may be mounted direct upon any vertical revolving part, or driven by pulley and belt from any rotating part of the machine.

Richardsons, Westgarth and Co., Limited, Hartlepool.—A copy of a neat and well illustrated catalogue containing a full description of the "Nesdrum" water-tube boiler, and illustrations of steam turbines and electrical machinery. Many claims are made for the "Nesdrum," among which may be mentioned that it is easy to transport, cheap to erect, and quickly cleaned; the construction of the boiler is simple, and it is stated to be an economical steam producer; it is less liable to give trouble than most other types through the tubes being covered with soot or scale, as the vertical arrangement of straight tubes minimises the amount of deposit which adheres to both the outside and inside surfaces.

J. P Morris Company, Port Richmond Ironworks, Philadelphia. —Bulletin No 1. This has been divided into two parts, the first giving a most interesting account of installations of turbine machinery. This company claims to have made the largest turbine in the world, which is one of 10,500 horse-power, constructed for the Shawinigan Water and Power Company, Canada. The second part deals with heavy centrifugal pumping machinery, and the description of the pumping station of the New Orleans Drainage Commission is worthy of special notice. Not only are, it is said, the pumps the largest ever made, but it is claimed that their efficiency has never been equalled in pumps of that type, and working under similar conditions. The firm is to be congratulated on the excellent way in which the catalogue has been arranged.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

In the engineering trades the period before the Christmas holidays is being characterised by activity in nearly all departments, especially in the electrical, hydraulic, and railway branches. Some of the motor builders are also still busy. Some good municipal contracts have lately been secured in this district for various classes of public works. The way in which the oversea trade in mining machinery is keeping up is affording great satisfaction to makers of this class of productions. The indents have been particularly good of late on account of South America, and, taking the year through, there has also been a considerable improvement with South Africa, whilst Australian requirements have also been more pronounced. A fair amount of constructional work is in progress, and the steel makers report the receipt of considerable orders for channels and girders needed in general constructional work and in the building of rolling stock for foreign railways.

The improvement in the iron and steel trades continues, and has been accentuated by the reports of increased activity which have been received from the United States. Expressions of satisfaction are heard on all hands that the year should be drawing to a close in so cheering a manner, and the current position presents a strong contrast to the situation which prevailed during the summer, when it was feared that the depression was not going to lift. Preparations are now being made for closing down for the Christmas holidays, which are not likely to be prolonged, for there is a considerable amount of work already on the books. Cinder forge—Staffordshire—is quoted 42s.; part-mine, 44s to 46s.; and other sorts the same as last week up to 100s. for best cold blast. There is an improved demand for Midland descriptions, with Northamptons at 42s. to 43s.; Derbyshires, 44s. to 45s; and Lincolns, 51s. 7d. Another furnace has been re-lighted at Dudley. In the manufactured iron trade demand is also better, and prices here and there are also a little firmer. The foreign demand for galvanised sheets keeps up satisfactorily. Merchant qualities of unmarked bars change hands at £5 15s., and common bars at slightly less, although even the latter are often quoted at £5 15s. to £6, there being still considerable difference between the open market quotation and the prices at which business is concluded. Marked bars are quoted £8, with Earl Dudley's brand, £8 12s. 6d., and the second grade of the list houses, £7. Galvanised corrugated sheets are still quoted £10 10s. to £10 15s.; while plain sheets, doubles, are £6 15s. to £7; singles being £6 12s. 6d. to £6 17s. 6d.; and trebles, £7 7s. 6d.

In the steel trade things are looking better than for some time past, with Bessemer billets quoted £4 7s. 6d. to £4 10s., and Siemens £4 12s. 6d. to £4 15s., whilst foreign competition is less prevalent than for some time past. Mild steel bars are quoted £6 to £6 5s., and girders £5 10s. to £6. There is plenty of work on the books to start the New Year, and the outlook is very favourable.

An interesting paper has been read before the Staffordshire Iron and Steel Institute on the Garrett reheating furnace, by Major Trinham, general manager of the Waverley Iron and Steel Works

Coatbridge, Scotland. At these works this furnace is being freely introduced, several having already been put down, whilst others are to follow. The patentee is Mr. George Garrett, of Coatbridge. It is a closed grate coal-fire furnace with regulated draught. The whole secret lies in the grate, the remainder of the furnace being built to suit local conditions, &c. It has been found that, compared with closed grate furnaces with steam jets, the Garrett furnace gives an increased output per shift of 2 tons 12 cwt., a reduced coal consumption of 1 cwt. 2 qr., and a reduced furnace waste of 2 per cent. The puddling and reheating furnaces at the works where the Garrett type of furnaces are in operation evaporate 1,243,920 lb. of water, at from 200 deg. to 212 deg. Fah., in twelve hours, and the total quantity of coal consumed during that time is about 80 tons, or, say, 179,200 lb. Then 1,243,920 ÷ 169,200 = 6·94 lb. of water per pound of fuel; and 13 of the 19 boilers at these works, and evaporating, as has been said, 6·94 lb. of water, belong to the puddling departments. Each furnace requires 4000 cubic feet of air per minute against a head of 4½in. w.g. The fan is an open one, so that any excess air churns back. It is belt-driven by a 15 horse-power reciprocating engine. The air is discharged into a 26in. diameter sheet iron central main, and branches 12in. diameter are led right and left to each furnace. A butterfly valve within the reach of the furnaceman regulates the blast to suit the condition of the iron in the furnace.

Much attention is being aroused among manufacturers on the question of industrial alcohol, and the Birmingham Chamber of Commerce is taking a prominent part in the agitation in favour of modifying the restrictions placed upon the use of alcohol in manufacture by the Inland Revenue authorities. The main grievance is, that in cases where foreign manufacturers are allowed by their Governments to use practically pure alcohol free of duty, the English manufacturer has to use methylated spirits, or pay a heavy duty. The trades principally affected are the makers of varnishes, lacquers, chemicals, explosives, analine dyes, and drugs, but many other traders suffer indirectly by the increased cost or inferior quality of the chemicals containing alcohol, which they use in their business. Among the witnesses from all parts of the country who have already been examined by the Industrial Alcohol Committee are three representatives of Birmingham industries—Mr. W. H. Bagley, of Messrs. Samuel Heath and Sons, brass founders; Mr. F. Barlow, managing director of the Birmingham Lacquer Company; and Mr. A. T. Cocking, resident director of Kynochs (Limited), and Alderman J. L. Gittings, Hills, and Co., varnish and lacquer manufacturers. The last two gentlemen attended before the Committee this week. There can be no doubt that more lacquer is used in Birmingham than in any other place, for it is the centre of the brass and other metal trades, and lacquer is largely used by every brass finisher and art metal worker. Even in the manufacture of varnish the use of spirit that has been denaturated by adding 10 per cent. of wood naphtha has the effect of clouding the varnish. The manufacturers contend that wood naphtha and turpentine are not the only effective denaturants, and that they should be allowed to mix the alcohol with denaturants that are not inimical to the process of manufacture. In the case of the lacquer manufacturers it is suggested that it is only necessary to mix the alcohol with shellac, which is impotable, and therefore would spoil the spirit for drinking purposes. Chemists claim that the revenue authorities should be satisfied if they saw the alcohol mixed with one or other of the constituents of the particular drug that was in process of manufacture. Motorists would probably be content if the spirit was mixed with 10 per cent. of petrol, which would render the liquid undrinkable, and would improve it as a motive power. With regard to the manufacture of explosives, it is argued that if pure alcohol could be used a much cheaper and less dangerous process could be adopted. The secretary of the Birmingham Chamber of Commerce is making further inquiries as to the practice in other countries.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—With the approach of the Christmas holidays the attendance on the Manchester Iron Exchange has shown, as usual, a tendency to diminish at this season, and there is not so much business passing as was the case a week or ten days ago. Generally speaking, however, the tone has been good all round, and notwithstanding the fact that employment in this district is not so good as it might be, it is better than it was a few weeks ago.

In the Manchester district, as well as at Oldham, more is being done in the textile machinery branches, which is, probably, as much as could be said of any portion of the year up to within the past month.

Machine tool makers are fairly well employed, and altogether, with one or two exceptions, it has not been a bad year in this particular branch. There was a strong close on Tuesday, and although one may not be induced to prophesy too much for next year, holders are not quoting lower rates, especially for finished iron, while in pig iron warrants have shown once more a tendency to steadiness. This does not affect this particular market so much, in face of the fact that Scotch iron is rather favoured here, in preference to Middlesbrough, prices of Scotch being more advantageous from the buyer's point of view.

Forge iron is comparatively easy, and some makers are bought forward for a considerable time. Prices, however, do not seem to decline.

Manufactured steel is exceedingly firm, and semi-manufactured brings full rates.

In pig iron it was noticeable that only comparatively small quantities changed hands. Sellers remained indifferent. Lancashire foundry iron, under these circumstances, brought about 6d. more as compared with last week, but there was no change to note either in Lincolnshire, Derbyshire, or Staffordshire foundry iron.

Quotations delivered Manchester are:—Lancashire No. 3 foundry, 52s. to 52s. 6d., and for small lots up to 53s.; Lincolnshire ditto, 51s. to 52s.; Derbyshire ditto, 52s. to 53s.; Staffordshire ditto, 52s.; Middlesbrough open brands, 55s. 10d. to 56s. 10d. Scotch: Gartsherrie, 56s. 6d. to 57s. 6d.; Glengarnock, 55s. to 55s. 6d.; Eglinton, 54s. 3d. to 54s. 9d. For prompt delivery Heysham; Gartsherrie, 54s. 3d. to 54s. 9d.; Glengarnock, 53s. 3d. to 53s. 9d.; Eglinton, 52s. to 52s. 6d.; East Coast foundry, 47s. 6d., f.o.t. Middlesbrough and West Coast, 55s. 9d., f.o.t. Barrow. Forge iron, Lancashire, 50s.; Derbyshire, 46s. to 47s.; Lincolnshire, 49s. 2d. to 49s. 6d., delivered Manchester.

In finished iron sellers report a healthy tone, and they ask full rates. There is, however, as usual, only a very ordinary consumptive demand passing at this season.

Quotations:—Staffordshire bars, &c., £6 5s. 6d. to £6 7s. 6d.; Lancashire and Yorkshire bars, £6 2s. 6d. to £6 5s., delivered stations; boiler plates, £6 17s. 6d.; hoops, £6 17s. 6d. to £7 2s. 6d.; sheets, ordinary, £7 5s.; C.R. and C.A. ditto, £7 15s. to £8, delivered Manchester. Steel bars, £6 to £6 2s. 6d.; English billets, £4 10s. to £4 12s. 6d.; German, £4 5s. to £4 7s. 6d.; hoops, £7 5s.

There are a few inquiries for locomotives, but they are not of any great extent, and there is not the same activity prevailing as was the case some two or three months ago. Copper sheets, in sympathy with the decline in the raw material, dropped £2 per ton at the close of last week, and sheets are being quoted £78 to £80 per ton. There was no change in other directions, seamless copper tubes being quoted 10d.; ditto brass, 8d.; rolled brass, 7½d.; copper wire, 9d.; and brass wire, 7½d. per lb.

There was about the average attendance on the Coal Exchange, and here, as in the iron trade, a more hopeful feeling ruled for next year. House coal has been very quiet and merchants place orders very sparingly.

Full time is now being worked in the Manchester district, and the cotton trade being very busy the demand for engine slack continues exceedingly good, with an upward tendency in prices.

Forge and manufacturing coal is exceedingly quiet, but the shipping trade remains steady.

Quotations:—Best coal for domestic purposes, 13s. to 14s.; seconds, 12s. to 13s.; common, 9s. to 10s.; steam and forge coal, best, 8s. 3d. to 8s. 9d.; best engine slack, 7s. 6d. to 8s.; medium, 6s. to 6s. 9d.; common, 4s. 3d. to 5s., at the pit. Screened coal, ex Manchester Ship Canal, 9s. 3d. to 9s. 9d.; unscreened ditto, 8s. 9d. to 9s. 2d.

Barrow.—The demand for hematite pig iron has shown no improvement during the past fortnight, but there is reason to expect a better business will soon be done by reason of the fact that there is a slackening off in foreign competition in the British markets. This is shown alike from the Continent and from America. Makers are better employed, but there is no great rush of orders. Yet indications are sufficiently satisfactory to justify preparations for the putting of additional furnaces in blast. One will be put in blast forthwith at the Millom Works, but even then the company will only have three of its ten furnaces in blast, and some idea of the condition of the iron trade may be gained from the fact that it is the largest producer of metal on the West Coast for the open market. It has no steel works to take up a portion of the output regularly. There are now 27 furnaces in blast in the district. Prices are steady at 56s. for makers' iron net f.o.b., and 56s. 1½d. for warrant iron net cash sellers, buyers 6d. less. Stocks remain low. In warrant stores 12,342 tons only are held.

The demand for iron ore is very quiet, and local mines are indifferently employed. There is likely, however, to be a marked improvement in this branch of trade. At present good average sorts are at 8s. 9d. per ton net at mines, and best sorts are at 11s.

The demand for steel rails is moderate, but makers are almost fully employed, although the prospect is not over hopeful, except from the point of view that there is less likelihood of foreign competition in the early future. Prices are steady at £4 5s. for heavy sections. A very quiet business is being done in light and tramway rail sections. Shipbuilding material is in very small demand, but there are hopes of improvement on local as well as on general account. Merchant steel is quiet and heavy steel castings and forgings are a small business.

It is reported that Vickers, Sons and Maxim have received an order from the Admiralty to build ten additional submarines of the B1 class. This vessel recently went through some highly successful evolutions outside Barrow Harbour, and the result is that the Admiralty have decided to strengthen their submarine flotilla by a further number of this class of boat. Indeed, it has now been demonstrated that the submarine has not only come to stay, but will play an important part in the future of naval warfare. It is, therefore, certain that the Admiralty will find it necessary to strengthen this branch of their service.

Shipping is quieter this week. The exports for the week include 4762 tons of pig iron and 3216 tons of steel, a total of 7978 tons, in contrast with 9015 tons in the corresponding week of last year. The total exports this year to date have been 712,606 tons, in contrast with 844,469 tons in the corresponding period of last year, a decrease of 131,863 tons.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE condition of the South Yorkshire coal trade continues satisfactory so far as volume of business is concerned. Although we have only occasional days of hard weather, the demand for house coal is active, more particularly for the better qualities. London and the Eastern Counties are taking a heavy tonnage, and the local business is well up to the average at this season of the year. In best Silkstones the trade is not very large at any time, and what is now doing rules at from 12s. 6d. to 13s. per ton. Barnsley house, which is chiefly in request, still fetches from 10s. 6d. to 11s. 6d. per ton at the pit mouth, secondary sorts making from 9s. per ton.

In hard coal the sales on home account are pretty much as usual in the last month of the year, but there is more than the average going by rail to the Humber ports. The prices range from 8s. 3d. to 8s. 6d. per ton, the latter being the rate at which railway companies are now generally receiving supplies. It is not anticipated, however, that coalowners will be able to quite maintain these figures in the new contracts for which arrangements are now being made. Of course, the trade this week has been under exceptional pressure in anticipation of the Christmas holidays, which will scarcely be so extended as in previous years—possibly two, and in some instances three days at Christmas and one or, perhaps, two days at New Year.

Gas coal, as is customary, is in brisk demand, and heavy weights are now being carbonised by Corporation gas departments and gas companies. The contracts for the coming year have for the most part been placed with the South Yorkshire coalowners on terms which show a reduction on what was obtained for previous supplies.

Best slacks and nuts are being fairly inquired after, and there is a much improved demand for common slack and smudge for steam generating purposes in the Lancashire cotton and Yorkshire woollen industries. The coke trade, if anything, is a little firmer, but the change for the better has not been sufficiently good to advance prices, good ordinary coke for foundry purposes fetching no more than from 8s. 6d. to 9s. per ton, and these rates will probably rule in the new contracts now in course of completion.

In the heavy departments no little interest has been excited this week by the decision of the Government with regard to the rearmament of the artillery. Two of our Sheffield firms, at least, will benefit directly—Messrs. Vickers, Sons and Maxim, Limited, and Messrs. Cammell, Laird and Co., Limited. In the latter case, no doubt, a large portion of the work will be done at the Coventry establishment of the company. The ten submarines ordered from Messrs. Vickers will, of course, concern the workpeople at Barrow more especially, although Sheffield will participate to some extent. Considerable disappointment has been expressed in this district owing to the Great Northern Railway Company having placed a considerable rail contract in the United States. There is also disappointment at the action of the Belfast Corporation in giving their electric tramway contract to an English-American firm. It is stated, however, that a large portion of the material will have to be made in England under sub-contracts, which will benefit to some extent the manufacturers of this country.

Several orders for heavy steel forgings have recently been received, and some of them supplied by our East End establishments, but there is a good deal less work doing in this direction than was anticipated would be the case at the close of the year. The machinery for the armoured cruisers at present building in the Government dockyards is understood to have been placed at London, Belfast, and Greenwich, and so far nothing is known of any of the work having been sub-let in Sheffield.

As is usual at the close of the year, the pig iron trade eases off somewhat, and there will be no movement of any consequence now until the fresh contracts for next year begin to be made. The quotations still maintain the advance previously noted, the ironmasters being in a position to stand by the lists. The call for home consumption was somewhat improved, the Frodingham makers delivering freely for the Lancashire districts, although they report less doing in shipments for Grimsby. In the Derbyshire iron district the local iron trade, though a little better, is not equal to what was anticipated, and no alteration now can be looked for until the New Year is well begun. Neither foundry nor engineering work is being largely booked, while the malleable iron and stove-grate trades remain as recently reported.

There is a fair amount of work doing generally in the steel trade, the principal demand still continuing for high-speed tool steel, the output of which continues to increase, owing to the uses to which it is put rapidly extending. The introduction of high-speed tool steel has beneficial effects, requiring the use of heavy machinery in the engineering trades. In this department British machine makers continue to hold their own against competitors.

In the lighter trades of the city there has been fairly good employment up to holiday time this week, but the prospects for 1905 are not quite so bright as it was expected they would be. In the cutlery trade, and in other wares into which ivory enters, the state of the ivory market causes considerable disquietude.

Messrs. Cammell, Laird and Co., Limited, Cyclops Works, Sheffield, amongst their other work, are engaged upon armour plates for H.M.S. Africa, the battleship now building at Chatham Dockyard. On the 16th inst., at Shoeburyness, a 12in. plate was tested, with entirely satisfactory results. Sir Alexander Wilson, who is to be congratulated on his complete recovery from his recent severe illness, was present on behalf of the company.

NORTH OF ENGLAND.

(From our own Correspondent.)

IT is becoming apparent that confidence is manifesting itself very generally in our iron and allied industries, though there does not seem to be anything prominent to bring it about. Traders, however, now are as "bullish" in their views as a short time ago they were pessimistic, and few doubt that 1905 will be a more favourable year than 1904 has been, as well in respect to profits as to demands. One of the main causes of this change for the better has been the improvement which it is acknowledged has taken place in the shipbuilding industry. Most builders have secured orders which will keep their yards going with fair regularity during at least the first half of the year; but so much that is favourable cannot be said of the profits they are likely to make, for the orders had to be taken at unprecedentedly low prices. It is, however, these prices that have tempted the shipowners. It seemed to be generally acknowledged that rates for new shipping had got as low as they were likely to fall, and those who waited would certainly have to pay more. Thus builders have done fairly well in the matter of booking fresh orders during the last three or four weeks, and the improvement has had its influence on several branches of the iron and steel trades.

Another indication of the improvement is found in the share market, for the shares of most of the leading iron and steel concerns have increased in value substantially during the last few weeks, which would seem to show that investors recognise that the worst of the depression is over, and that next year they may look for satisfactory dividends. Lately the South Durham Steel and Iron Company's ordinary shares were down at 4s. 9d., now they have risen to 12s.; the same company's 6 per cent. cumulative preference have advanced from 7s. 6d. to 17s.; and the 4 per cent. debenture from 70 to 82. Dorman, Long and Co.'s ordinaries have risen from 9s. 9d. to 14s.; Weardale deferred ordinaries, from 13s. to 18s. 9d.; and the 6 per cent. cumulative preference, from 14s. 3d. to 17s. 3d. Then Bolckow, Vaughan's all-paid ordinaries, have advanced from 16s. 9d. to 20s., and the part-paid from 8s. 9d. to 10s. 9d.; while Armstrong's are up from 51s. to 61s. 6d. These are a few instances from among many of the better feeling that has sprung up.

The warrant market has been firmer this week, and every day some improvement in the price of Cleveland warrants has had to be noted, until the best price of the year has again been reached, and sellers are no longer in a hurry to dispose of their warrants, for they believe that by holding to them till after Christmas their profits will be considerably enhanced. On Monday the price of Cleveland warrants got back to 48s. cash buyers, on Tuesday 48s. 5d. was offered, and on Wednesday 48s. 8d. This is the more satisfactory, as in the week before Christmas no one would have been surprised if prices had gone down, especially when the stock continues to increase so rapidly in the public warrant stores. The difference between the price of Cleveland warrants and that of maker's iron has been so great this week as to render it more profitable to sell warrants and to put iron into the public stores to meet the transactions. Connal's stock of Cleveland iron is now 175,565 tons, no less than 25,965 tons having been added this month, and about 80,000 tons since October 1st. The quantity now held is the largest that has been reported for five or six years, and it is considerably more than double the quantity held in the summer.

Consumers have during this week bought Cleveland pig iron more fully, as there is some likelihood that prices will not be lower, especially if the speculators keep up their game till the spring, as it is said the leading spirits mean to do. In these circumstances buyers are reported to be desirous of purchasing for delivery over the whole of the first half of 1905. There has this week been a renewal of the American inquiries for Cleveland pig iron, but prices are too high to admit of any actual business being transacted. A representative of some leading American houses has this week waited upon some of the ironmasters with a view to business if the situation continues to improve in the States. No. 1 Cleveland pig iron has risen to 49s. 3d., No. 3 to 47s. 9d., No. 4 foundry to 46s., No. 4 forge to 45s., mottled to 44s., and white to 43s.

Makers of East Coast hematite pig iron speak rather cheerfully of their prospects, owing to the revival of shipbuilding. More plates and angles will be needed, and that means a greater demand for hematite iron. Not less than 53s. 6d. per ton will be taken for mixed numbers. Cost of production continues to rise, for further advances have been made by the mine owners in Spain, and merchants on this side have no alternative but to raise their quotations likewise, notwithstanding that the freight from Bilbao to the Tees has dropped to 4s. 3d. Thus merchants, who a short time ago were selling Rubio ore at 14s. 6d. per ton c.i.f. Tees, now quote 15s. 6d., but consumers hold off. The condition in which the ore is received at this season renders it necessary to get better prices, as very little ore comes out at 50 per cent., owing to the larger amount of moisture which it contains.

The exports of pig iron from the Cleveland district for December are fair. Up to 21st they reached 53,429 tons, against 50,085 tons last month, and 52,531 tons in December last year to 21st. There is also a large increase in the shipments of steel, which reached 18,368 tons, against only 7229 tons last December, and of manufactured iron the exports were 9551 tons, against 10,015 tons. Deliveries of pig iron to oversea destinations have improved, and Scotch consumers are likewise taking more.

The Cargo Fleet Iron Company, Limited, which had its general offices in the Royal Exchange, Middlesbrough, since that building was erected in 1868, will remove them to the works at the close of next week, but the secretarial duties will be carried on at the Moor-street Works of the South Durham Steel and Iron Company at Stockton, the two companies having practically been amalgamated. Messrs. Dorman, Long and Co., Limited, early in the new year will remove their commercial offices from the works to the offices in Zetland-road, Middlesbrough, lately occupied by the Cleveland Ironmasters' and Mine Owners' Associations. It is interesting to note that these latter Associations have removed to the buildings in Cleveland-street, Middlesbrough, which were once the private residences of Mr. Bolckow and Mr. Vaughan, the founders of the Cleveland iron trade.

The demand for manufactured iron and steel continues to improve, though only somewhat slowly. Almost everyone is looking for prices being advanced, and in no department is there any likelihood of their being easier with cost of production increasing. There is some reason to believe that the make of plates will be augmented by the restarting of some of the idle plant. For steel ship plates the price is firm at £5 15s., less 2½ per cent.; for iron ship plates £6, less 2½ per cent.; for steel ship angles £5 5s., less 2½ per cent.; and for iron ship angles £6 2s. 6d., less 2½ per cent. Bar manufacturers have more to do, and speak hopefully of their prospects. An endeavour is being made to bring about the establishment of an angle manufacturers' combination, similar to that which exists in the plate trade, and the firms in this district have

been approached on the question. It is probable that one of the largest of the firms will hold aloof from any arrangement of this kind.

The prospects for shipbuilders, as is stated above, are more encouraging, and orders for new vessels are more freely placed. Among the orders lately given out is one from Messrs. J. Sutton and Co, Newcastle, for a 4000-ton cargo steamer, which has been secured by Messrs. Swan, Hunter and Wigham Richardson, Wallsend. Messrs. Wood, Skinner and Co., of Bill Quay-on-Tyne, have obtained an order from the Leafield Steamship Company, Limited, for a 4350 tons deadweight cargo steamer, and one from Messrs. Arnott, Newcastle, for a 1000-ton deadweight steamer. Messrs. Robert Stephenson and Co., Wallsend, have secured another order for a steamer of over 6000 tons for West Hartlepool owners, and at their yard they have now five steamers in course of construction, each exceeding 6000 tons carrying capacity.

Sir Edward Grey has been elected chairman of the North-Eastern Railway Company in place of the late Viscount Ridley. A new vice-chairman will have to be elected now that Sir Lowthian Bell has passed away.

The market for steam coals is quiet, and some easing of prices must be reported as far as regards best qualities, there having been business at 8s. 10½d. f.o.b., and even at this it is difficult to negotiate sales. Middlemen who are obliged to take the quantities due to them are underselling the owners. The deliveries of gas coals are very heavy, and very little more can be raised at the collieries. Thus the price of best is at 8s. 3d., and seconds at 7s. 10½d. f.o.b. Coking coal is in fair request at 8s. 3d. to 8s. 9d. The coke market is hardly so strong as it was last week, and sellers are disappointed that there are so few people wanting coke for delivery in Christmas week, for which they have to pay exceptional prices. Most of the contracts for next half-year have now been placed, and on the whole the sellers have not done badly. For medium quality 14s. 9d. per ton is taken, delivered at the Middlesbrough furnaces next half-year.

The report of the Cleveland Bridge and Engineering Company, Limited, Darlington, states that the gross profit for the year ended September 30th was £12,189. The dividend on the ordinary shares will be at the rate of 7½ per cent. per annum. The directors state that the work in connection with the new high-level bridge over the Tyne has made most satisfactory progress; all the foundations are finished, the large river piers are being built, and the steel superstructure prepared. The work at the bridge at Victoria Falls, Zambesi River, is being successfully carried out.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been a moderate business doing this week in the pig iron market, but the transactions that have taken place appear to have been mainly of a speculative nature. The near approach of the holidays has naturally led consumers to purchase only what is absolutely required. Business has been done in Cleveland warrants at 48s. 5d. to 48s. 6d. cash, 48s. 7½d. to 48s. 8d. for delivery in twenty days, and 48s. 7½d. to 48s. 9d. one month. The demand for Scotch hematite pig iron has been quiet, and merchants quote 48s. to 48s. 6d. per ton for delivery at the West of Scotland steel works.

The output of pig iron in Scotland has so far been fully maintained. There are 85 furnaces in blast, compared with the same number at this time last year, and of the total, 41 are making ordinary, 38 hematite, and six basic iron.

The stock of pig iron in Glasgow warrant stores shows an increase for the past week of 474 tons, and now amounts to 10,796 tons, being 1506 more than at the beginning of the year.

Prices of Scotch makers' iron do not show much alteration. G.M.B., f.o.b. at Glasgow, No. 1, is quoted 54s.; No. 3, 51s.; Carnbroe, No. 1, 55s.; No. 3, 52s.; Clyde, No. 1, 57s. 6d.; No. 3, 53s.; Langloan, No. 1, 64s.; No. 3, 54s.; Gartsherrie, No. 1, 58s.; No. 3, 53s. 6d.; Summerlee, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Coltness, No. 1, 64s.; No. 3, 54s. 6d.; Glengarnock, at Ardrossan, No. 1, 58s.; No. 3, 52s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 53s. 6d.; No. 3, 51s.; Shotts, at Leith, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Carron, at Grangemouth, No. 1, 58s. 6d.; No. 3, 53s. 6d. per ton.

The shipments of pig iron from Scottish ports in the past week amounted to 6473 tons, compared with 3993 in the corresponding week of last year.

The arrivals of Middlesbrough pig iron at Grangemouth amounted to 8725 tons, compared with 9104 in the corresponding week, showing a decrease of 379 tons.

There is little to report this week with reference to the finished iron and steel trades. Business has, generally speaking, been quiet, and the orders coming to hand are comparatively few. The steel makers in a number of cases still report that specifications are difficult to obtain. A fair amount of work is being done in the engineering trades, which are, however, unequally employed, some branches being busy while others are quiet.

The coal trade has, on the whole, been active. The volume of shipments, while varying in some districts, is, on the whole, rather larger than in the preceding week, and it is now apparent that the statistics for the year will show an aggregate export exceeding that of 1903 by several hundred thousand tons. Main coal is quoted f.o.b. at Glasgow 7s. to 7s. 6d.; ell, 8s. 3d. to 8s. 9d.; steam, 8s. 6d. to 8s. 9d.; and splint, 8s. 6d. to 9s. per ton. The home department of the coal trade is active, household coals selling briskly at full rates.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

NEARING the holidays has perceptibly improved the coal trade, though more buoyancy would have been acceptable, and cleared off sidings more expeditiously. Coalowners who wanted wagons released have had to make slight abatements, otherwise ruling quotations remain tolerably firm, and in the Cardiff district best Admiralty still command from 13s. to 13s. 3d., and in some cases 13s. 6d.

Large and best coals may be taken as firm; small steams an unsteady market; Monmouthshire semi-bituminous fluctuating, one day rather in demand, the next drooping.

One of the largest coal contracts for Cardiff is now virtually settled—that of the Compagnie Générale, though particulars are withheld. It is understood on 'Change that the price ranges from 12s. 6d. to 13s., but that some qualities have been bought under 12s. The quantity is from 250,000 to 300,000 tons, distributed amongst about half a dozen collieries.

Another subject commented on by members is the selection of ten or a dozen steamers by Japanese agents for the conveyance of a large quantity of coal, one estimate being 150,000 tons.

Mid-week more definite information was forthcoming to the effect that three Liverpool steamers had been chartered to carry about 25,000 tons of Cardiff coal to Japan. Two are now loading, and the third will load in January. The figures given are about 18s. 6d. Russia is quite, if not more, actively engaged in securing Welsh coal; and the latest news is that a number of steamers have got safely into Vladivostock. Most were from Shanghai, and the premium ranged from 30 to 35 guineas. Names and nationalities of the steamers are concealed, but it is understood that cargoes are sent openly to Shanghai, and that war risks begin from that port. One of the clearances—Tuesday—from Cardiff was to Hongkong, 5800 tons. Capetown took nearly 9000 tons, and Port Said and Brindisi large consignments. One of the shipments the same day was 1000 tons of patent fuel to Dakar, and another the same quantity to Pernambuco.

Closing prices, Cardiff, this week were:—Best Admiralty, 13s. to 13s. 6d.; seconds, 12s. 6d. to 13s.; ordinary seconds, 11s. 6d. to 12s.; drys, 11s. 9d. to 12s. 3d.; best smalls, 7s. to 7s. 3d.; best ordinaries, 6s. to 6s. 6d.; seconds, 5s. 6d. to 6s.; inferiors, including drys, 5s. to 5s. 3d. Monmouthshire semi-bituminous: Large, 11s. 6d. to 11s. 9d.; best ordinaries, 11s. 3d. to 11s. 6d.; seconds, 10s. 3d. to 10s. 9d. House coal, 16s. 6d. to 17s., firm, with tendency to advance; best ordinaries, 13s. 6d. to 14s. 6d.; seconds and other kinds, 10s. 6d. to 13s. No. 3 Rhondda, 13s. 3d. to 13s. 6d.; brush, 11s. 6d. to 11s. 9d.; small, 9s. 6d. No 2 Rhondda, 9s. 9d.; through, 8s. 3d to 8s. 6d.; small, 6s. 6d. to 6s. 9d. Patent fuel, 12s. 6d. to 13s. Coke continues to improve in demand, furnace qualities selling from 16s. to 16s. 6d., and foundry from 18s. to 21s. 6d. Pitwood, 17s. 6d.

Forward demands continue rather weak at Cardiff and Newport, but a fair amount of business is certain to end of the year.

At Swansea, last week, shipment was not so brisk as the preceding, and delayed tonnage told on shipments of coal and patent fuel. This week there is more doing, and, as little free coal is on the market, prices are firm, and likely to advance. Latest quotations are: Steam, 12s 6d. to 13s.; seconds at 10s. 6d.; bunkers, 8s. 9d. to 9s.; small, 5s. 9d. to 6s. 9d.; No. 3 Rhondda, 13s. 6d. to 13s. 9d.; through, 9s. 6d. to 10s. 6d.; small, 8s. 9d. to 9s.; patent fuel, 11s. 6d. to 11s. 9d., including tax; anthracite, best malting, 20s. to 21s.; seconds, 17s.; big vein, 12s. to 12s. 3d.; red vein, 10s.; cobbles, 17s. 6d. to 18s.; nuts, 18s. to 20s.; peas, 11s. to 12s.; culm is still weak, latest price, 4s. 6d.

Sir Lowthian Bell, the ironmaster, whose death is announced at the advanced age of eighty-eight, was at one time associated with the iron and steel trade of Wales, and figured with Sir W. T. Lewis and the late Mr. Edward Williams, of Middlesbrough, in the restart of Treforest works. These works did a large trade with tinplate work in the days of pig iron, but when steel was largely substituted for iron the trade decayed. There was a vigorous effort made to equip Treforest for the new order of things, and a colliery is still in work on the estate.

The latest published statistics show a falling off in the make of steel in Wales. For this year, in Bessemer steel, the production in Wales has been 40,000 tons less than last year; and in open-hearth steel ingots, 52,000 less.

Arrivals of German steel continue, nearly 2000 tons coming from Antwerp to Newport, Mon., and beyond small consignments on home account there has been no important despatch from Wales or Monmouthshire, with the exception of rails from Dowlais for South America. At these works the rail make continues satisfactory. In steel bars for the tin-plate district a tolerable quantity has been made of late at local works, particularly in the Swansea Valley. Some degree of quietness may now be expected, as during the holiday time repairs will come into evidence.

Imports during this week bulked largely of iron ore from Spain. Ebbw Vale one day this week imported 8760 tons and 10 tons of pig iron; and Guest, Keen and Co., 2800 tons ore.

In pig iron there has been a decline in price of Scotch warrants to the extent of 1s. per ton, but Middlesbrough has advanced 10½d. and Cleveland hematite, 6d. upon the week. Tin bars are advancing, and the plate quotations remain very firm; order-books reported well filled.

The following are the latest general quotations on 'Change Swansea:—Glasgow pig iron warrants, 52s.; Middlesbrough No. 3, 48s. 4½d.; hematite, 55s. 6d; Welsh bars, £6 2s. 6d.; sheet iron, £8 5s. to £8 10s.; steel sheets, £8 2s. 6d. to £8 5s.; steel rails, heavy, £4 10s. to £4 12s. 6d.; light, £5 10s. to £5 12s. 6d.; Bessemer steel tin-plate bars, £4 5s.; Siemens best, £4 7s. 6d.

Tin-plates: Bessemer steel coke, 12s. 9d. to 13s.; Siemens, coke finish, 13s. to 13s. 3d.; ternes, per double box, 28 by 20 C., 23s. 6d. to 25s. 6d.; best charcoal, 14s. 6d. to 15s.; big sheets for galvanising, 6ft. by 3ft. by 30 g., per ton, £9 to £9 5s.; finished black plate, £8 17s. 6d. to £9 2s. 6d.; block tin, £133; lead, £12 18s. 9d.; spelter, £25. Copper: Chili bars, £66 2s. 6d. Iron ore: Rubio, 14s.

The tin-plate exports last week were again large, 78,097 boxes; receipts from works 73,178 boxes. Stocks are now only a little over 102,000 boxes. One of the features of the week was the despatch to the Far East of a cargo of 6000 tons. "Oilers" are in demand; coke tins I.C. quoted at 12s. 1½d. to 12s. 3d.

In the Swansea valley there has been a good deal of activity at Upper Forest, Pontardawe, Landore, and Cwmfelin. Other industries are doing well; work is regular at the copper works, and the make of spelter is vigorously maintained.

I regret to note that in the Swansea district some of the collieries are irregular in work, and it is reported that horses and tools have been brought up from the Copper Pit, Morriston. In the Aberavon district seventy-three cases of abstention have occurred at the Duffryn Rhondda collieries. Staying from work in consequence of a fatal accident, occurring at another pit, the management took a merciful view of the cases, and on condition that twelve paid cost, no further action was taken. This amounted to 6s. each man.

The coal trimming difficulty has been acute at Barry. This week an important meeting of representatives was held in Cardiff to consider the matter and discuss the proposed new coal trimming tariff for the ports of Cardiff, Penarth, and Barry. The result is said to be satisfactory, but particulars are withheld. I hear that, as regards present arrangements, any "self-trimming steamers" which come to Barry are loaded without difficulty by the ordinary gangs of trimmers. The Evan Thomas (Radcliffe and Co.) steamer the Llangorse was so laden this week. Basis of new tariff is likely to be 1d. or 1½d. per ton.

At Llanelly prospects are decidedly hopeful. This week, at a meeting of the Harbour Trust, the chairman reported that the trade was steadily increasing month by month.

Application for extension of time is to be sought in Council for the Rhondda tramway scheme.

In the Dean Forest coalfield an important meeting will take place on Boxing Day, with a view to carry out suggestions for the development of the mineral riches of the district.

NOTES FROM GERMANY.

(From our own Correspondent.)

THERE has been a little more life stirring in the iron industry this week than last, and the physiognomy of the iron market is comparatively bright.

In Silesia the tone all round has been more confident, and inquiry generally increasing, both for raw and for manufactured iron The Upper Silesian Steel Convention, that has been formed as a member of the German Steel Convention, will commence operations on the 1st of January, 1905; from that period the Upper Silesian Rolling Mill Convention will cease to exist.

Malleable iron is well inquired for, and orders for the first quarter in 1905 are being placed pretty freely. There is generally less reserve shown, and the number of forward contracts has increased of late; about one-quarter of all the orders booked is, however, for foreign consumption.

Also from the finished iron department more hopeful accounts are being received. There was a fair demand noticeable in rails, hoops, and sectional iron, and girders, too, are in satisfactory request, the terms of delivery varying between two to six weeks. Consumers in plates continue to show much reserve.

Though moderate activity and a comparative want of large contracts is still reported from many branches of the Rhenish-Westphalian iron industry, there has yet been a marked improvement noticeable in some trades, inland demand being more active than formerly, and the tone generally a trifle more confident. The Steel Convention has resolved to maintain the present prices for semi-finished steel in the immediate future.

Shipments of the Steel Convention in October of present year have been 99,000 t. girders and sectional iron; 140,000 semi-finished steel; 121,000 t. railway material. The total shipments from March 1st of the present year till October 31st, were 1,152,000 girders and sectional iron, 1,078,000 semi-finished steel, 894,300 t. railway material.

Deliveries on home account were 268,000 t. for October, against 269,000 t. in September; deliveries on foreign account were 93,000 t. against 90,000 t. in September. From March 1st to October 31st home deliveries were 2,330,000 t., those on foreign account being 795,500 t. Orders reaching up to the end of the year were, according to the *Rhenish-Westphalian Gazette*, on November 1st, in sectional iron 194,000 t., in semi-finished steel 245,000 t., in railway material 387,400 t.

The export bounties for the first quarter in 1905 have been fixed as follows:—For coal, M. 1·50; pig iron, M. 4·86; mild steel, M. 15; and sectional iron, M. 20; al per ton. An export bounty for pig iron can only be granted under condition that the receiver of the bounty does not buy pig iron, or spiegeleisen, too, from works outside the Syndicate, without the permission of the latter.

A steady improvement can be reported from the coal industry in Silesia; both house coal and engine fuel are extremely well inquired for, and deliveries during the week have been heavy. The colliers' strike in the Neurode district in Lower Silesia has not been without influence on the Upper Silesian coal market, as fairly large lots had to be sent to Breslau and the neighbourhood.

The consumption in gas coal and coal for coke making continues brisk as before, and the inquiry for coke is likewise very active, both locally and on foreign account.

Also in Rheinland-Westphalia an improving demand is reported from the coal market, gas coal being most actively inquired for; coke and small coal are rather less lively than in previous weeks, especially blast furnace and foundry coke is in somewhat limited request. For briquettes the demand continues to increase.

A very firm tone characterises the pig iron market of Austria-Hungary. In merchant iron also a lively trade is done. The united rail works have recently submitted an offer for a five years' supply in rails to the State Railways at prices lower than those of the recent offer that was rejected. Building material is rather dull, while for merchant iron a fair demand comes in.

For engine coal numerous orders have come in on the Austro-Hungarian market. The sugar mills purchase heavily now. The reduction in tariffs for coal from the Ostrau-Karwin district to Galicia that will come into force on January 1st are expected to raise the demand for coal from that country, and coke, too, will most likely profit by the said reduction.

The French iron trade has shown little or no improvement since the previous week, the iron works in the Haute-Marne being the only ones that can be reported in active employment.

On the French coal market house coal has improved in demand, while engine fuel remains somewhat dull. Quotations are stiff on the whole.

The only improvement that can be reported from the Belgian iron industry is that prices have become firmer, in consequence of the successful activity of the conventions. Demand and consumption in the different trades remain much as last reported, and must be considered somewhat languid.

The tone of the Belgian coal market may be stated as fairly bright and satisfactory, house coal having steadily improved in demand since last report.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market is firmer, a better supply of tonnage having come on. House coal in fair demand, both for shipment and inland trade. The quantity of coal shipped for the week ending December 24th was 74,443 tons; foreign, 58,914 tons: coastwise, 15,529 tons. Imports for the week ending December 20th:—Iron ore, 11,560 tons; bars, &c., 4200 tons; pig iron, 510 tons; slates, 174 tons; pitwood, 518 loads.

Coal—Best steam, 11s. 6d. to 11s. 9d.; seconds, 10s. 6d. to 10s. 9d.; house coal, best, 15s.; dock screenings, 6s.; colliery small, 5s. 6d. to 5s. 9d.; smiths' coal, 9s. Pig iron—Scotch warrants, 52s. 6d.; Middlesbrough No. 3, 48s. 8d.; Middlesbrough hematite, 55s. 9d. Iron ore—Rubio, 14s. 6d. to 14s. 9d.; Tafna, 15s. 6d. to 15s. 9d. Steel—Rails, heavy sections, £4 10s. to £4 12s. 6d.; light ditto, £5 10s. to £5 12s. 6d.; Bessemer steel tin-plate bars, £4 5s.; Siemens steel tin-plate bars, £4 7s. 6d. Tin-plates—Bessemer steel, coke, 12s. 9d. to 13s.; Siemens, coke finish, 13s. to 13s. 3d. Pitwood—17s. 6d. to 17s. 9d., ex ship. London Exchange telegrams—Copper, £66 2s. 6d. to £66 5s.; Straits tin, £132 15s. to £132 17s. 6d.

Freights firm, rates steady.

TRADE AND BUSINESS ANNOUNCEMENTS.

WERNER, PFLEIDERER AND PERKINS, Limited, have removed their head offices to Westwood Works, Peterborough.

PRIESTMAN BROTHERS, Limited, inform us that as their lease at 32, Victoria-street, Westminster, expires on the 25th, they are moving to 3, Laurence Pountney-hill, Cannon-street.

SAML. DENISON AND SON, Limited, advise us that for family purposes they have converted their business into a private limited company. The management of the business will be precisely as before.

MR. VINCENT S. ALLPRESS, M. Inst. C.E., informs us that his partnership with Mr. W. H. Massey has been dissolved by mutual consent. He continues to practise at 25, Queen Anne's-gate, Westminster.

WE are asked to state that the cables used in the electrification of the Metropolitan Railway, including approximately 75 miles of three-core, 11,000 volt, three-phase armoured cable, and the low-tension lead-covered rubber cables for making the connections to the positive and negative rails, have been supplied by the British Insulated and Helsby Cables, Limited, which company has also done all the connecting up.

CONTRACTS.—The British Electric Plant Company, Limited, informs us that it has been awarded by the Alloa Coal Company the contract for a complete electric power plant on the direct-current system for the Bannockburn collieries, together with engines for the same.—Messrs. John H. Wilson and Co., Limited, of Liverpool, have been entrusted with the order for two powerful steam permanent way breakdown cranes for the Shanghai-Nanking Railway.—Last week, the Great Western Railway Company placed with Kerr, Stuart and Co.—for the purposes of comparison with their vertical boiler motor coaches—a sample order for two steam motor coaches on the "Kerr-Stuart" system, with transverse locomotive boiler. The Lancashire and Yorkshire Railway also, at the same time, ordered from Kerr, Stuart and Co., two coaches of the same type as are now being built for the Taff Vale Railway.—The Billericay Rural District Council have instructed Messrs. Merryweather and Sons to prepare a water supply scheme for Billericay and a number of surrounding villages.—The Hart Accumulator Company, Limited, informs us that its tender has been accepted by the Deptford Borough Council for additions and alterations to the existing battery installed at the Public Baths, New Cross, S.E.—The Lancashire Dynamo and Motor Company, Limited, has received an order from the Admiralty for the whole of the electrical equipment for Malta Dockyard, including boilers, engines, dynamos, motor generators, and motors, in accordance with the specification of Messrs. Preece and Cardew.—The Hart Accumulator Company's tender has been accepted by the Llandudno Urban District Council to supply 256 of their standard lighting type cells having a capacity of 450 ampère hours.—Horace P. Marshall and Co. have recently received an order from Messrs. Vickers, Sons and Maxim, Limited, Barrow-in-Furness, for fifty pneumatic tools, consisting of Boyer hammers, and Little Giant and Boyer drills, for their shipyard.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, December 7th.

THE fact that premiums are being already paid over the official prices for nearly all kinds of finished material shows that an extraordinary consumptive demand has been precipitated upon the market. Premiums ranging from 1 dol. to 2 dols. per ton were paid every day last week on wire products, tubes, billets, and tin-plate. Nearly all the iron and steel associations will hold meetings during the next two weeks, and at these meetings the present exceptional condition of things will be considered, possibly advances of prices will be determined upon, and in anticipation of this possibility a great deal of business has recently been done. Another factor which has contributed to the phenomenal activity of the market is the refusal of many of the large independent plants to accept further business excepting at an advance over current rates. Tin-plate has been advanced 5 to 10 cents per box for prompt shipment. It is expected that sheet and tin-plate bars and billets will be advanced before the close of this week.

The railroads have suddenly become active buyers for all kinds of material, including rolling stock and locomotives. Already the great equipment plants have contracts extending throughout the winter, and it is estimated that within the past month contracts for 60,000 cars have been placed. From estimates received it is probable that early in the New Year the car building orders will aggregate 75,000 cars, which, of course, include requirements for plates, structural shapes, and other kinds of finished material. The requirements can be covered, as at the present time the independent mills are running to only 75 per cent. of capacity, while the corporation mills are running almost to maximum capacity. The sheet and tin-plate mills are running to about 85 per cent. of capacity, and new capacity is being called upon every day.

The rail pool will meet in this city in a few days and will re-establish the price of 28 dols. for the coming year, for standard sections.

Had the railroad companies made concessions on freight rates, the railmakers would have made concessions on rails. Large quantities of old rails have been sold within a few days in order to make room for new rails to be delivered in the spring. These old rails sold at prices varying from 22 dols. to 25 dols. per ton.

There is also a strong demand for machinery and tools and a great deal of shop and mill equipment, as well as equipment for electrical plants, and makers find it necessary to enlarge their shop facilities to supply the material that is wanted.

Last week's copper shipments were a record breaker—the exports for week ending Friday being 7917 tons. During the first few days of December the shipments amounted to 1003 tons, and for the first 11 months of the year 227,682 tons, against 122,578 tons during the same time last year, an increase this year over last of 105,104 tons. Large sales of electrolytic have been made for shipment to London and to German markets at from 15s. to 20s. under the nominally quoted prices.

A great deal of copper is now being purchased for domestic consumption. Chinese interests are buying heavily, and the probabilities are that the copper requirements from that quarter of the world will be greatly increased. The estimated consumption of copper in Europe during the first nine months of the current year was increased from 104,000 tons compared with the consumption of 1903, in which Germany figured as the largest consumer, taking 48,000 tons more during that period than in the same period of last year. There has been a marked revival in the electrical industry in this country during the past two months, and a great deal of work is in sight which will be presented for estimating during the first and second quarters of next year. There will be less copper to spare for export in consequence. During the current year the average monthly exportation amounted to 20,000 tons.

NEW YORK, December 14th.

The pool which has been forcing up tin prices for the past six months has come to an end. The largest producers of tin unloaded their November and December product at full prices, and these same producers are now on the other side of the market. A reaction is evidenced on all sides. Further violent fluctuations are threatened. During the past week the local tin market dropped from 29·60 to 28·80. Receipts in this city thus far during December have been 665 tons, and arrivals booked for next week for American ports figure up 2675 tons. Lead has shown weakness at 4·70 for spot, and 4·60 in thirty days.

The rise in steel products continues. Large lots of material are offered at speculative prices. The railroad companies are liberal buyers for both shop supplies and equipment. In addition to these requirements rail mills have received information that upwards of 1,000,000 tons of rails will be contracted for, possibly before the close of this year. The price has been fixed upon for the coming year, and no change over current rates has been made. The price of sheets and tin plates and galvanised has been advanced 2 dols. per ton in anticipation of an advance of 2 dols. per ton in billets. Plates and structural shapes are to be advanced in a few days, which will amount to 2 dols. to 4 dols. per ton. Soft steel bars will move up 2 dols. per ton as soon as the strike in the Youngstown district is settled. This advance will be followed by another in January. Light steel rails will also be advanced about 1 dol. per ton about the same time.

The present production of pig iron is at the rate of 18,000,000 tons annually. The present melting amounts to 1,630,000 tons per month, or 19,560,000 tons per year, which means that the present melting absorption is 130,000 tons per month in excess of present production.

This is the reason of the present upward tendency in prices. Production cannot be rapidly increased, although we have sufficient furnace capacity to make an increase, on account of the difficulty of obtaining ore. There is another difficulty in the supply of coke. There is also a traffic congestion at some points, which prevents coke shipments; then, again, a good many furnaces "catch cold" in the winter, and do not produce as much and as evenly as in the summer months. The great steel companies are melting 1,000,000 tons of steel pig per month, and this is not enough. This accounts for the large contracts which have been placed with the Bessemer furnaces in the two valleys. During the past eleven months the steel companies have produced 9,174,317 tons, and the merchant furnaces have produced during that time 5,339,237 tons, a total of 14,514,041 tons; adding the December production of 1,500,000 tons estimated, we have a total production for 1904 of 16,014,041 tons. More furnaces are blowing in, and the capacity for the coming year will be at the rate of 18,000,000 tons, as above stated.

The speculators in copper are driving up prices. December exports of copper so far are 5024 tons. During the past two months 4000 tons have been shipped to China. Some of our domestic consumers do not think the present high prices will last, and many of them are not buying for very remote delivery. The exports of copper during the past week were 4021 tons. It is estimated that the exports of copper during December to all markets abroad will be in the neighbourhood of 23,000 tons, which will make the exports during the current calendar year 250,000 tons.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

7th December, 1904.

26,612. STEERING AXLES of VEHICLES, E. Fairweather, Croydon.
26,613. COVER for TOBACCO PIPES, J. H. Harris, Coventry.
26,614. PNEUMATIC TIRES, H. Brookes, Stirchley, near Birmingham.
26,615. VICE GRIPS for BENCHES, W. G. Watson, Birmingham.
26,616. EXTENDER for DRESS SLEEVES, M. Marsters, Nottingham.
26,617. SPEED REGULATORS for MACHINERY, A. Macdonald, Glasgow.
26,618. SHIFTING TRAMWAY POINTS, A. Taylor, jun., Glasgow.
26,619. CHAFF CUTTERS, S. and C. Cooper, Birmingham.
26,620. STEAM GENERATOR, W. Baldwin, Blackburn.
26,621. FOSTER-MOTHERS for POULTRY, G. W. Phipps, Birmingham.
26,622. CASEMENT STAYS and FASTENERS, C. R. Casake, Southampton.
26,623. CENTRIFUGAL CREAM SEPARATORS, J. Mélotte, Birmingham.
26,624. CONNECTING ARTICLES or PARTS, J. Mélotte, Birmingham.
26,625. FIXING MINIATURE HOLDERS to CHAINS, J. Rooker, Birmingham.
26,626. FLEXIBLE SHAFT COUPLING, T. Humpage, Bristol.
26,627. COVERING for WATER-CLOSET SEATS, C. M. B. H. Triscott, Dublin.
26,628. INTERNAL COMBUSTION MOTORS, A. J. Rowledge, Surbiton Hill, Surrey.
26,629. PNEUMATIC TIRES, H. W. Hopburn, Liverpool.
26,630 TRUCKS for TRANSPORTING GOODS, J. A. J. Hayes, Manchester.
26,631. STOPPERS for BOTTLES, T. Butler, Manchester.
26,632. VENTILATING BUILDINGS, W. H. Hoyle and T. Barker, Manchester.
26,633. NON-SLIPPING TIRES, S. J. Wrightson and J. H. Winter, Rawcliffe, R.S.O., Yorks.
26,634. BUFFER GUIDES, W. Gatwood and G. H. Willans, Wrexham.
26,635. MACHINE for BENDING WOODEN HOOPS, T. Small, Glasgow.
26,636. REVOLVING TUBULAR STREET ADVERTISER, I. Melcher, Cardiff.
26,637. "HOOF PADS" for ANIMALS, J. Cliff, Manchester.
26,638. RETAINING the FRONT of a COAT in POSITION, H. F. Young, Bournemouth West.
26,639. SPRINKLERS of AUTOMATIC FIRE-EXTINGUISHING APPARATUS, F. W. Reed and Craven Brothers, Limited, Manchester.
26,640. PREVENTING the SKIDDING of PNEUMATIC-TIRED VEHICLES, J. E. T. Ambrose, and H. E. and F. W. Prosser, Birmingham.
26,641. STANDS for DISPLAYING ARTICLES, S. Timings, Birmingham.
26,642. SECURING DOOR KNOBS, H. Watkin, Birmingham.
26,643. PROCESS for TREATING SOOT, A. Macknight London.
26,644. PRESERVING FOOD, A. E. Sherman, Liverpool.
26,645. DETACHABLE TOP PIECES for HEELS of BOOTS, P. Y. Harrison and R. H. Southall, Leeds
26,646. MAKING TROUSERS, F. Hansing, Loughton, Essex.
26,647. PIANOS, F. M. Howard, Hamilton, Ontario, Canada.
26,648. CLAMPING DEVICE, B. Knittel, Dresden, Germany.
26,649. COMPOUND for MEDICINE, F. Livingstone.—(*A. Stein, Austria.*)
26,650. BACTERIOLOGICAL WARM STAGE, H. C. Ross, London.
26,651. PLUG TAP, The Horsehay Company, Limited, and T. H. Williams, London.
26,652. SAFETY DEVICE for SCREW NUTS, H. M. J. von Metzen, London.
26,653. DIVIDING INSTRUMENTS for DRAWING, T. English, London.
26,654. PROTEID, G. Mitchell, London.
26,655. BRIDLES for HORSE RIDING, T. B. O'Connor, London.
26,656. ELECTRIC LAMPS, W. Goulton, London.
26,657. CHEESE and BUTTER CUTTER, C. A. Maddison, London.
26,658. APPLIANCE for PLANING DESKS, A. C. Drake, Tollesbury, Essex.
26,659. PRODUCING CARBONIC ACID GAS, J. C. Stead, London.
26,660. DEVELOPING PHOTOGRAPHS in DAYLIGHT, F. H. Goodwin, London.
26,661. LOOM MOTIONS, R. J. McKeown and A. Bunting, Belfast.
26,662. BOTTLE, Lord de Morley and H. E. Burgess, London.
26,663. FASTENERS for WINDOW SASHES, G. Wefers, London.
26,664. ENGINES, A. H. Herdtlé and A. T. Bruneau, London.
26,665. STEAM TURBINE-DRIVEN STEERING GEAR and RUDDER BRAKES COMBINED, J. Roberts, Liverpool.
26,666. FLUID-CIRCULATION APPARATUS, J. Selwig, Brunswick, Germany.
26,667. BRAKING and CLUTCHING DEVICES, P. Hallot, London.
26,668. SPECTACLE and EYEGLASS CASES, W. E. Cooke, London.
26,669. EXTRACTING STEAM from AIR, W. J. Hudson and A. Crooke, London.
26,670. EXTRACTING STEAM from AIR, W. J. Hudson and A. Crooke, London.
26,671. SECURING BRUSH-HEADS to HANDLES, J. M. Madden, London.
26,672. BED POCKET, C. J. Gawthrop, Wolsingham, R.S.O., Co. Durham.
26,673. BOXES, E. Unger, London.
26,674. STICKS for MANIPULATING COUPLINGS, E. J. Hill, London.
26,675. POTATO DIGGERS, W. Crooke, jun., and W. H. Godfrey, London.
26,676. TIRE VULCANISING APPARATUS, G. W. T. Leeson, Birmingham.
26,677. WRINGING MACHINE ROLLERS, R. Lancaster, London.
26,678. BOILING PANS, H. B. Merton, London.
26,679. ELECTRIC CURRENT PROTECTING DEVICES, W. Schiffler, London.
26,680. AUTOMATIC LIGHTING of STREET LAMPS, J. L. Bruce, London.
26,681. DRIVING GEAR for MOTOR CARS, E. V. E. Louet, London.
26,682. FIRE SPRINKLERS, W. J. Cox, London.
26,683. VEHICLE WHEEL RIMS, F. A. Seiberling, London.
26,684. CUSHIONING VEHICLE WHEELS, F. A. Seiberling, London.
26,685. APPARATUS for TAPPING CASKS, United Engineering Company, Limited, and J. McRae, London.
26,686. ELECTRIC TELEGRAPHS, Siemens Brothers and Co., Limited, and G. S. Grimston, London.
26,687. CYCLE BRAKES, J. Dring, London.
26,688. PAPER BAG MAKING MACHINES, O. Hesser, Liverpool.
26,689. STEREOSCOPES, C. Pietzner, London.
26,690. FILING LETTER APPLIANCE, J. A. Houghton, London.
26,691. DRAWING FRAMES, J. A. Houghton, London.
26,692. TEMPORARY BINDERS, H. R. S. Pulman and G. Higginson, London.
26,693. RINGING PAPER and CARDBOARD, G. Higginson, London.
26,694. TURF CUTTER, W. L. Corry, London.
26,695. STEAM-CLEANSING APPARATUS, D. B. Morison, London.
26,696. WIRELESS TELEGRAPHY APPARATUS, S. Eisenstein, London.
26,697. GOVERNORS for GAS BURNERS, J. A. Richmond, London.
26,698. PROCESS of FERMENTATION, J. T. and T. H. Board, London.
26,699. MOTOR-CONTROLLING SYSTEMS, A. C. Eastwood, London.
26,700. DRIVING MACHINERY, J. Nuttall, G. Bentley, and A. A. Whitley, London.
26,701. BOTTLE STOPPERS, W. Hucks and W. Hucks, jun., London.
26,702. BAROMETERS, A. Sutherland, Inverness, N.B.

8th December, 1904.

26,703. WHEEL for VEHICLES, J. and A. Robertson, Ashton-on-Mersey.
26,704. CLIPS for SUPPORTING WIRES, A. R. Walmsley, Halifax.
26,705. ADJUSTABLE SASHES, C. Brooks, Harrogate, Yorks.
26,706. SAFETY LAMP, B. J. Hicks and R. Downing, Stockton-on-Tees.
26,707. MOULDING of COOKED MEAL, A. H. Valda, Teddington, Middlesex.
26,708. AUTOMATIC STARTERS for ELECTRIC MOTORS, C. W. Webster, Bradford.
26,709. FUSE BOXES for ELECTRIC MAINS, A. S. Blackman, Bradford.
26,710. HEELS for BOOTS and SHOES, A. Mallaby, Bradford.
26,711. WHEELS, W. G. Hicks, Bracknell, Berks.
26,712. STORING LEAVES of TELESCOPIC TABLES, F. M. Farr, Manchester.
26,713. SACCHARINE, O. Oberlander and The Alliance Chemical Company, Limited, Bury.
26,714. PAPER FILES, T. E. Bingham, Manchester.
26,715. PREVENTING the INSERTION of KEYS in KEY-HOLES, J. and W. T. Fletcher, Wolverhampton.
26,716. CRAMP for CASTING BOXES, W. H. Butler and J. Barnsley, Sheffield.
26,717. FEET of TOAST STANDS, H Lawrence, Birmingham.
26,718. MEANS for PREVENTING REFILLING of BOTTLES, W. Brown, W. E. W. Cates, and E. E. J. Farquhar, Bristol.
26,719. RING LEVER for BICYCLES, J. P. E. C. Stromeyer, West Didsbury, Lancs.
26,720. APPLIANCE for VERIFYING MEASURES, T. Finney, Glasgow.
26,721. INCANDESCENT GAS BURNERS, H. Harper, Birmingham.
26,722. PREVENTING the EXPLOSION of CANS of EXPLOSIVE FLUIDS, M. Dreckmann, E. Marx and E. Knobisauch, Charenton-Seine, France.
26,723. OPERATING VALVES of WATER CISTERNS, H. Harrison, Birmingham.
26,724. PAPER HOLDERS, H. Wybrow, Birmingham.
26,725. COVERS for PNEUMATIC TIRES, E. H. Hill, Sheffield.
26,726. SWIMMING ACCESSORY, J. Foster and W. R. Monkhouse, Manchester.
26,727. LUBRICATING AXLES of COLLIERY WAGONS, J. Berry. Manchester.
26,728. EXPLOSIVE SHELLS, W. S Simpson. London.
26,729. INCANDESCENT GAS LIGHTING, W. Horton, London.
26,730. GUARD for PLATEN PRINTING MACHINES, J. E. Westoby, Hull.
26,731. GAME of SKILL, A. J. Smith, Glasgow.
26,732. HAULAGE CLIPS for COUPLING HUTCHES, D. Russell, Glasgow.
26,733. DRINKING TROUGHS for ANIMALS, T. C. Maddock, Birmingham.
26,734. BALL VALVES, W. Voysey and S. G. Mason, Birmingham.
26,735. STEAM BOILERS, T. Staples, Birmingham.
26,736. TIRES for MOTOR CARS, N. M. Cohen, London.
26,737. HEATING SOLDERING IRONS, J. Adams, Birmingham.
26,738. SHIPS' VENTILATORS, D. Fotheringham, Liverpool.
26,739. MEANS for LOCKING NUTS, D. Marshall, Cheltenham, Gloucestershire.
26,740. SMYRNA CARPET WARPS, B. S. and R. N. W. Smith, London.
26,741. ROTARY ENGINES, W. Anderson, H. Duncan, and W. Walker, London.
26,742. STARTING GEAR for ENGINES, H. Reid and J. Rieke, London.
26,743. BOOT CLEANER, C. R. Bee and C. E. Gadd, Manchester.
26,744. DISPLAYING ADVERTISEMENTS, P. Sheldon, London.
26,745. BRACKETS for MOTOR LAMPS, I. R. Van Wart, London.
26,746. FIRE ALARMS, J. Fiddes and J. F. Watt, London.
26,747. MANUFACTURE of ASPHALT, A. C. Bamlett, London.
26,748. TELEGRAPHIC INSTRUMENTS, Marconi's Wireless Telegraph Company, Limited, and E. Priddle, London.
26,749. SHOW CASE, L. J. Everest, London.
26,750. IMPROVED ADVERTISING DEVICE, A. Dunhill, London.
26,751. APPARATUS for FINING BEER, P. G. Hart, London.
26,752. TIRES for MOTOR CAR WHEELS, W. C. Barker, London.
26,753. INTERNAL COMBUSTION ENGINES, E. W. Lewis, Coventry.
26,754. INCANDESCENT GAS BURNER, E. C. R. Harvey, London.
26,755. BILLIARD CHALK HOLDERS, F. C. R. Harvey, London.
26,756. WHEELS for SELF-PROPELLED VEHICLES, G. M. Robertson, London.
26,757. WORKING SIGNALLING BELLS, Siemens Bros. and Co., Limited.—(*Siemens and Halske Act.-Ges., Germany.*)
26,758. MOTOR VEHICLES, M. K. Ryan, London.
26,759. MUSCLE-DEVELOPING APPARATUS, P. A. Valle and F. H. Ayres, London.
26,760. WHARFEDALE PRINTING MACHINES, H. Bonham, London.
26,761. ELECTRIC ARC LAMPS, J. M. Wellingt n and W. F. Daniell, London.
26,762. FIELD GUN CARRIAGES, A. T. Dawson and G. T. Buckham, London.
26,763. APPARATUS for CATCHING FISH, H. K. Ingham, London.
26,764. WATER GAUGES for STEAM BOILERS, G. Midgley, London.
26,765. CLOTHES PROPS, A. E. Hobson, London.
26,766. INFLATING FISHING PALLETS, J. Bloomfield, London.
26,767. MECHANICALLY-PROPELLED BICYCLES, H. L. Havers, London.
26,768. DRAWING MACHINE, D. R. Clarke, London.
26,769. HIGH-SPEED ENGINES for MOTOR CARS, S. J. Williams, London.
26,770. MANUFACTURE of POWER GAS, E. Fleischer, London.
26,771. PROTECTIVE CAP for HAT-PINS, J. G. Meakes, London.
26,772. ELECTRO-MAGNETIC APPARATUS, H. H. Lake.—(*C. J. Schwarz and A. M. Kells, United States.*)
26,773. HAND STITCHING MACHINE, F. Küstner and F. W. Powell, London.
26,774. TIE FASTENER, C. A. R. Thornberry, London.
26,775. PROJECTILES, W. Strickland, London.
26,776. RIVETS for PNEUMATIC TIRE COVERS, V. M. Crawford, London.
26,777. VARIABLE SPEED GEAR, M. M. Smith and A. H. Constable, London.
26,778. TREATMENT of WASTE TANNING MATERIALS, E. E. M. Payne, London.
26,779. MANUFACTURE of CAMPHOR, A. Zimmerman.—(*Chemische Fabrik auf. Actien. vorm. E. Schering, Germany.*)
26,780. SELF-OILING WHEELS, H. M. Gregory, London.
26,781. FISHING REELS, E. A. Fisher, London.
26,782. VACUUM BRAKES, The Consolidated Engineering Company, Limited, and H. E. Brown, London.
26,783. BOOTS and SHOES, W. Schrimshaw, London.
26,784. MEDICATED CAPSULES, E. M. Pond, London.
26,785. ROTATING MECHANISM, A. Herbert and P. V. Vernon, London.
26,786. RENDERING the INSULATION of ELECTRIC CONDUCTORS FIREPROOF, G. G. M. Hardingham.—(*Felten and Guilleaume Carlswerk Akt.-Ges., Germany.*)
26,787. COLLAR STUDS, M. G. and D. R. de Simone, London.
26,788. CAPSTANS, S. Strickland and Co., Limited, and H. J. Inder, London.
26,789. TINS, Maconochie's Solderless Tinning Syndicate, Limited, and J. Shirreffs, London.
26,790. PRODUCING METALLIC PERBORATES, G. W. Johnson.—(*Deutsche Gold and Silber-Scheide Anstalt vormals Rössler, Germany.*)
26,791. COMPOUNDING TRANSFORMERS, A. Heyland, Liverpool.
26,792. HAIR WAVER, M. Ihde, London.
26,793. FIREARMS, H. P. Okie, London.
26,794. HOT WATER HEATING SYSTEMS, O. Lindemann.—(*Gebruder Korting Act.-Ges., Germany.*)
26,795. PROPS for MINES, E. Morhenn, London.
26,796. PIPES, S. G. Luciano, London.
26,797. STEAM GENERATORS, A. Adiassewich, London.
26,798. INK BOTTLES, J. Marshall, London.
26,799. HOLDERS for ELECTRIC LAMPS, J. C. Dear, London.
26,800. SLIDING WINDOWS for CARRIAGES, A. Eongarts, London.
26,801. IMPROVED COLLAPSIBLE TRESTLE, J. Girand, London.
26,802. CASK-BRANDING MACHINE, J. Ingle and W. J. Green, London.
26,803. TYPEWRITING MACHINES, R. W. James.—(*The Monarch Typewriter Company, United States.*)
26,804. TYPEWRITING MACHINES, R. W. James.—(*The Union Typewriter Company, United States.*)
26,805. ALTERNATING CURRENT ELECTRO-MOTOR, F. M. Lewis, London.
26,806. ANTI-SKIDDING DEVICE for MOTOR CARS, R. V. Jellicoe, London.

9th December, 1904.

26,807. AUTOMATIC STOKERS for HEATING APPARATUS, D. Wilson, Blackburn.
26,808. FASTENING BUTTONS, W. Hörner, Barmen, Germany.
26,809. TOASTING BEFORE a FIRE, C. Berner, London.
26,810. BOBBIN CARRIERS, G. Skinner, Bolton.
26,811. INSTRUMENT for DRAWING CIRCLES, B. Shorthouse, London.
26,812. MEANS for ADVERTISING, J. Dyson, Manchester.
26,813. FOLDING TAPE, P. J. Purdy and H. Wilson, Manchester.
26,814. CIRCULATING the COOLING WATER of MOTOR CARS, S. W. Smith, Manchester.
26,815. PORTABLE APPARATUS for DIPPING SHEEP, R. P. Cooper, Berkhamstead, Herts.
26,816. LOOM DOBBIES, E. Hollingworth, Dobcross, Yorks.
26,817. EXPOSED SEATS, J. Heaton and A. Wood, Bradford.
26,818. TIDE MILL, T. B. Stoney, Co. Donegal, Ireland.
26,819. CARBURETTERS, F. H. Royce, Manchester.
26,820. ELECTRICAL SWITCHES and CUT-OUTS, C. M. Dorman, R. A. Smith, and H. G. Baggs, Salford.
26,821. EYELET or WASHER, C. Maher and E. G. Moore, Liverpool.
26,822. MATS and FLOOR COVERINGS, H. V. Roe, Manchester.
26,823. APPLYING a SHIFTING LATCH BOLT to RIM LOCKS, W. G. and E. Webster, Willenhall, Staffs.
26,824. GAUGES for USE in STEREOTYPING, W. Ward, Hull.
26,825. SAFETY LEVER for LOCKS, J. Taylor, Willenhall, Staffs.
26,826. FURNACES, G. Watson and H. W. Mason, Leeds.
26,827. APPLYING TENSION to DRIVING BANDS, J. Boyd, London.
26,828. CONVERTIBLE VULCANISER FLASK, R. W. Brenmehl, Greenock.
26,829. ROLLER BEARINGS, W. Houldsworth, Manchester.
26,830. LATHES, J. Barrow, Glasgow.
26,831. GOLF BALLS, R. F. and C. A. Hutchison, Glasgow.
26,832. SEWAGE DISTRIBUTOR, W. Percival and T. Tindal, Stoke-on-Trent.
26,833. ROLLING and HARROWING FIELDS, H P. Huggins, London.
26,834. LETTER and PAPER FILES, J. and B. J. Appleby, London.
26,835. ENGINE or MACHINE PACKING, G. W. Beldam, Liverpool.
26,836. COOLING FRAMES for SOAP, A. E. Boardman, Warrington.
26,837. COVERS for INCANDESCENT BURNERS, J. Whalley, Halifax.
26,838. GAS COOKERS, W. Johnson, Liverpool.
26,839. MINERS' LAMPS, W. Sands and T. B. Senter, Glasgow.
26,840. MACHINES for MOULDING SLABS, J. C. Sellars, Birkenhead.
26,841. FITTING SPRAYING STOPPERS to TUBES, K. Paxton, London.
26,842. TILE PRESSES, J. O. Palmer, H. A. Smith, and R. Bloom, London.
26,843. FIRE-EXTINGUISHING APPLIANCES, A. Bruce, Glasgow.
26,844. WINDOW and PRICE TICKETS, W. J. Edkins, Birmingham.
26,845. MEANS for REMOVING the COVERS of VERTICAL FURNACES, Steel, Peech and Tozer, Limited, and T. Green, Sheffield.
26,846. MAKING CARPETS and RUGS, G. H. Naumann, London.
26,847. NECK-TIES, P. Clasen, London.
26,848. SECURING CURTAIN HANGERS, J. Schleiss, London.

26,849. ELECTRO-DEPOSITION of METALS, B. M. Bailey, Birmingham.
26,850. ADVERTISING, G. E. Taylor and T. Temperley, London.
26,851. CHANGE SPEED GEAR, J. C. Dennis, London.
26,852. WEIGHING MACHINES, J. S. Pooley, Dumbarton, N.B.
26,853. CYCLE SADDLES and SEATS, J. W. Richardson, London.
26,854. PRINTING SURFACES, W. J. Yeoell, London.
26,855. LAUNCHING of SHIPS' BOATS, R. H. Robinson, London.
26,856. VEHICLE LAMP, T. D. McCall, Leith, N.B.
26,857. WHEELS for MOTOR CARS, G. L. Cumberland, London.
26,858. UNIVERSAL WONDER FIGURE, A. Zehnpfenning, Hamburg, Germany.
26,859. ENDORSING STAMPS, S. H. de Lacy, London.
26,860. BOTTLES for HOLDING LIQUIDS, H. M. Glasgow and M. W. Carmichael, London.
26,861. CONVERTIBLE RUG, A. Loder, London.
26,862 MARKING FRAMES for PICTURES, A. E. Vidal, London.
26,863. FIRE-BARS for STEAM BOILER FURNACES, N. F. Johnson and W. F. H. Hinde, London.
26,864. PHOTOGRAPHIC DARK ROOM LAMPS, E. A. Jahn, London.
26,865. ADJUSTING REAR-SIGHT of FIRE-ARMS, J. Hassell, Woolwich.
26,866 DOLL, J. R. Hitchings and W. Terry, Brighton.
26,867. NON-SLIPPING TIRE BANDS for MOTOR CARS, A. L. Radford, London.
26,868. MANUFACTURE of REFLEX HINGES, E. D. Payne, Birmingham.
26,869. TUMBLER, O. Madlung, London.
26,870. AUTOMATIC BLAST PIPE APPARATUS, R. H. Whitelegg, London.
26,871. BOOT TREES, W. W. Beals, London.
26,872. TESTING MACHINES, M. H. P. R. Sankey, London.
26,873. DRY-CLOSETS, T. C. Line and T. N. Castle, London.
26,874. APPARATUS for HOISTING COAL, T. G. Wrightson and J. M. Ringquist, London.
26,875. CASTING the BUSHES of SELF-OILING WHEELS, H. M. Gregory, London.
26,876. CORKS or STOPPERS for BOTTLES, E. de la Rue, London.
26,877. SHOW-CARDS, E. de la Rue, London.
26,878. CONSTRUCTING FIRE-RESISTING FLOORS, H. Todd, London.
26,879. PURIFICATION of COAL GASES, P. E. Williams, London.
26,880. SUPPLY PASSAGES of PUMPING ENGINES, H. S. Rexworthy, London.
26,881. TREATING ORES of VANADIUM, A. H. Perret, London.
26,882. INHALERS, L. A. Carré, London.
26,883. ATTACHMENTS for PHONOGRAPHS, F. Myers, London.
26,884. ATTACHMENTS for PHONOGRAPHS, F. Myers, London.
26,885. TRACK FASTENERS, C. H. Tibbetts, London.
26,886. OPENING and CLOSING APPARATUS for WINDOWS, S. E. Aldwinckle, London.
26,887. THREE-PHASE GROUND DETECTORS, P. MacGahan, London.
26,888. WAISTBANDS, E. Abadie-Léotard, London.
26,889. LAMPS, F. H. H. and W. F. H. Ward, and L. Blériot, London.
26,890. ACETYLENE GENERATORS for USE in LAMPS, F. H. H. and W. F. H. Ward, and L. Blériot, London.
26,891. SCREW PROPELLERS, W. Preidel, London.
26,892. APPARATUS for PETROLISING AIR, C. Fowler, London.
26,893. FORM of STUD for SPECTACLES, S. Druiff, London.
26,894. DOOR CHECKS, J. Bardsley, London.
26,895. WATER-HEATING APPARATUS, C. J. Jones and W. M. Still, London.
26,896. BOGIES for RAILWAY VEHICLES, A. Spencer, London.
26,897. PHONOGRAPHIC APPARATUS, C. A. McEvoy, Welwyn, Herts.
26,898. MACHINES for CLEARING POTATOES, E. Maxwell, London.
26,899. MANUFACTURE of STEREOTYPES, R. C. Annand, London.
26,900. CORSETS, E. Abadie-Léotard, London.
26,901. STANDS for SHOWING BRUSHES, J. B. Kendrick, London.
26,902. VENTILATOR, C. A. Lowe, London.
26,903. BUILDING VENTILATION, S. S. Stitt and G. C. Luff, London.
26,904. THILL COUPLING, J. D. Tam, London.
26,905. PURIFYING COFFEE, N. J. H. Weitzmann, London.
26,906. ELECTRIC DEMAND INDICATORS, J. R. Dick, and the Reason Manufacturing Company, Limited, London.
26,907. DISCHARGING GAS RETORTS, Compagnie Anonyme Continentale pour la Fabrication des Compteurs à Gaz et Autres Appareils, London.
26,908. AZO COLOURING MATTER, J. Y. Johnson.—(*Badische Anilin and Soda Fabrik, Germany.*)
26,909. AZO COLOURING MATTER, J. Y. Johnson.—(*Badische Anilin and Soda Fabrik, Germany.*)
26,910. APPARATUS for DRYING TEA LEAF, W. Jackson, London.
26,911. PUMPS, P. H. Deis, London.
26,912. FOLDING BEDS, L. Andersson, London.
26,913. AIGRETTES, E. Zappert.—(*The Aigrette Supply Company, United States.*)
26,914. ARTIFICIAL AIGRETTES, E. Zappret. —(*The Aigrette Supply Company, United States.*)
26,915. ELECTRODES for ARC LAMPS, J. T. H. Dempster, London.
26,916. ARC LAMP ELECTRODES, C. P. Steinmetz, London.
26,917. ELECTRODES for ARC LAMPS, W. R. Whitney, London.
26,918. ARC LAMPS and ELECTRODES, J. Härdén, London.
26,919. ARC LIGHT ELECTRODES, J. Härdén, London.
26,920. ARC LIGHT ELECTRODES, C. F. Lindsay, London.
26,921. ELECTRODES for ARC LAMPS, W. S. Weedon, London.
26,922. ARC LIGHT ELECTRODES, W. S. Weedon, London.
26,923. ELECTRIC RHEOSTATS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,924. HOT-WATER SERVICE for BATHS, C. and A. Hillier, Birmingham.
26,925. ELECTRICAL MEASURING INSTRUMENTS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,926. WINDOW CURTAIN HANGERS, J. J. Cochran, United States.
26,927. BOTTLE CLOSURES, C. E. McManus, United States.
26,928. ELEVATOR ATTACHMENTS, H. A. Henderson, United States.

10th December, 1904.

26,929. STRENGTHENING PAPER BANDS, H. Isringhaus, Barmen, Germany.
26,930. FRAME for BORING MACHINES, C. Walker, Doncaster.
26,931. COTTON-SPINNING MACHINES, W. Tweedale, Castleton, near Manchester.
26,932. HEATING APPARATUS for CABINS, A. N. Low, Glasgow.
26,933. NEW TABLE GAME, M. H. F. Jackson, Andreas, Isle of Man.
26,934. BEATING DOWN PAVING BLOCKS, S. H. Adams, Scotswood-on-Tyne.
26,935. DIRECT-ACTING PUMPS, P. W. Lockwood, Glasgow.
26,936. VENTILATORS, W. C. Morison, Wolverhampton.
26,937. MECHANICAL PIANO PLAYERS, S. Howard, Manchester.
26,938. SHIELDS for BOBBINS, Wilson Bros. Bobbin Company, Limited, and H. W. Wilson, Manchester.
26,939. GAS FIRES for GRATES, Planet Foundry Company, Limited, and G. F. Calderwood, Manchester.
26,940. APPLIANCE for RAISING SHIPS, T. Boxhon, Liverpool.
26,941. BEDSTEADS and BEDRESTS, H. Lewis, Birmingham.
26,942. ADJUSTMENT of WAIST BELTS, C. Hirst, Glasgow.
26,943. SPINNING MULES, W. Muir and Howard and Bullough, Limited, Accrington.
26,944. BALING PRESSES, J. R. Pumphrey, Kingston-on-Thames.
26,945. GOLF BALLS, A. Macdonald, Glasgow.
26,946. SECURING JOINTS between METAL and RUBBER PIPES, T. G. Land, South Benfleet, Essex.
26,947. CLEANING METALLIC SURFACES, B. J. B. Mills.—(*T. A. Edison, United States.*)
26,948. STORAGE BATTERIES, B. J. B. Mills.—(*T. A. Edison, United States.*)
26,949. NICKEL PLATING APPARATUS, B. J. B. Mills.—(*T. A. Edison, United States.*)
26,950. VEGETABLE JELLY TABLET, W. H. Chapman, jun., Liverpool.
26,951. ADJUSTABLE CLIP, W. Potter, London.
26,952. MANUFACTURE of TUBES, H. Scoltock, West Bromwich.
26,953. COMPUTING STEELYARD, J. Toon, Derby.
26,954. AIR COMPRESSORS, J. Wood and Sons, Limited, Wigan, Lancs.
26,955. ADVERTISING FRAMES and BOARDS, A. Emett, London.
26,956. FRICTION CLUTCH, J. W. Brown, Ashbourne, Derbyshire.
26,957. SIGNALLING, C. H. Pym and E. J. Witcombe, Bristol.
26,958. PAINT BRUSHES, R. Bennett and W. Joyce, Manchester.
26,959. STEAM REVERSING ENGINE GEAR, J. Gilmour, London.
26,960. COLLAPSIBLE or FOLDING BOXES, J. E. McEwen, London.
26,961. CONTROLLING the SUPPLY of AIR to CARBURETTERS, R. N. Sharp, J. H. Ingle, and H. Thornton, Leeds.
26,962. SECURING RUBBER PADS to BOOT HEELS, S. Gilbert, Cropwell Butler, Notts.
26,963. REVERSING SETS of MOTOR BOATS, C. W. H. Scott, Carlisle.
26,964. GOLF CLUB, A. Simpson, Edinburgh.
26,965. SPRING WHEEL, A. G. Ramage, Edinburgh.
26,966. ANGLE-MEASURING INSTRUMENTS, A. König, Germany.
26,967. CARTRIDGE HOLDERS for MAGAZINE RIFLES, L. S. Hollings, Birmingham.
26,968. VARIABLE SPEED GEAR, R. W. Wilson and F. G. D. Johnston, London.
26,969. CLEANING BAKING TINS, G. H. and C. H. W. Cliff, London.
26,970. FIRE-LIGHTERS, G. C. Chambers, Lond m.
26,971. BOOT BRUSHES, G. C. Chambers, London.
26,972. CARBURETTING SYSTEMS, &c., W. A. Taylor, Coventry.
26,973. CHANGE SPEED MECHANISM, G. Richards, London.
26,974. MANUFACTURE of EXPLOSIVES, A. C. Luck, Ipswich.
26,975. APPARATUS for SIGNALLING, W. Brierley, London.
26,976. MOTORS, E. Towlson, H. R. Moulton, and G. T. Hiam, London.
26,977. ADVERTISING DEVICES, J. H. Jay, London.
26,978. APPARATUS for DRYING SLURRY, E. Allen and Co., Limited, T. W. Leach, sen., and T. W. Leach, jun., Sheffield.
26,979. HYDRAULIC BRAKES for CYCLES, F. G. Heath and the Heath Hydraulic Brake Company, Limited, Birmingham.
26,980. HARVESTERS, T. N. Johnson and J. F. Phillips, London.
26,981. HARVESTERS, T. N. Johnson and J. F. Phillips, London.
26,982. LEVER for PNEUMATIC TIRES, C. E. Hoefling, London.
26,983. LIQUID FUEL COOKING APPARATUS, H. Goetze, Dresden, Germany.
26,984. WEIGHING MACHINE, E. E. Reichwald.—(*A. Spies G. m. b. H., Germany.*)
26,985. ELECTRICAL SWITCHES, G. Page and A., J. H., L. W., and E. Holmes, London.
26,986. VARIABLE SPEED GEAR, H. V. James and R. A. Marples, London.
26,987. DEVICE for INDICATING when a LAMP is EXTINGUISHED, H. Brough, London.
26,988. MEANS for PREVENTING SIDE-SLIP, T. G. Allen, London.
26,989. STEAM GENERATORS, Simpson, Strickland and Co., Limited, and G. P. Jarvis, London.
26,990. HIGH-PRESSURE GAS BURNERS, A. G. Melhuish, London.
26,991. COLLAPSIBLE HAND TRUCK, A. R. Francis, London.
26,992. SEALING of DOCUMENTS, F. H. Sterling, London.
26,993. MECHANICALLY OPERATED TOOLS, H. John, London.
26,994. BUCKET ELEVATORS, O. Krell, sen., Liverpool.
26,995. APPARATUS for FILLING BARRELS, B. M. Jager, Liverpool.
26,996. COUPLINGS for DEEP BORING TOOLS, W. Hoos, London.
26,997. TELEPHONE APPARATUS, W. M. Still and A. G. Adamson, London.
26,998. MECHANICAL PLANERS for DECKS, C. Schofield, London.
26,999. APPARATUS for FILLING SACKS, A. W. Timewell, London.
27,000. ELECTRO-MAGNETS, D. L. Lindquist, London.
27,001. DEPILATING MACHINES, H. H. Lake. —(*The Turner Tanning Machinery Company, United States.*)
27,002. PADLOCKS, A. Bénassy, London.
27,003. ELECTRIC SWITCHES, A. Bénassy, London.
27,004. BUFFING MACHINES, A. J. Boult.—(*S. W. Winslow, United States.*)
27,005. PRIMING COMPOSITIONS, J. Wetter.—(*Westfälisch Anhaltische Sprengstoff-Akt.-Ges., Germany.*)
27,006. AUTOMATIC IGNITERS for GAS BURNERS, F. Deimel and ——, Administrators of P. Deimel, London.
27,007. MILK DELIVERY CANS, G. R. Speaker.—(*Kleiner and Fleischmann, Austria.*)
27,008. CLIPS for FOUNTAIN PENS, R. T. Brond, London.
27,009. BRACES and SUSPENDERS, R. Garrett, jun., London.
27,010. FREQUENCY CHANGERS, O. O. Kruh, London.
27,011. VAPOUR ELECTRIC APPARATUS, O. O. Kruh, London.

12th December, 1904.

27,012. BARREL SUPPORTS, H. Kirkham, Melksham, Wilts.
27,013. KNITTING MACHINES, I. H. Parsons and H. R. Waddington, Leicester.
27,014. BOOTS, J. B. Scammell, London.
27,015. STOPPER for USE with BOTTLES, J. Lyon, Birmingham.
27,016. INTERNAL COMBUSTION ENGINES, E. W. Walford, Coventry.
27,017. UMBRELLAS, D. Harris, Mountain Ash, Glam.
27,018. STOPPERS for USE with BOTTLES, J. Lyon, Birmingham.
27,019. TRAVELLER for RING SPINNING, J. L. Rushton, Manchester.
27,020. INCANDESCENT GAS BURNERS, J. C. McIntosh, Glasgow.
27,021. PERPETUAL MOTION, R. Burow, London.
27,022. TEACHER'S BOOK, A. Cooper and A. J. Smith, Ipswich.
27,023. PHOTO-MECHANICAL COLOUR REPRODUCTION, C. G. Zander, London.
27,024. PROTECTING GROUNDROPES of TRAWL NETS, W. H. Thickett, Hull.
27,025. CYCLE HOLDER, W. Dickie, Glasgow.
27,026. VENT and SAFETY STOPPER, P. W. Taylor, Banbury, Warwickshire.
27,027. AUTOMATIC LAMP LIGHTING, G. H. Cawthorn, West Hartlepool.
27,028. ELECTRIC CONDUIT SYSTEMS, T. T. Dewhirst and B. Biggs, London.
27,029. COLOUR MEASURING DEVICE, J. B. King, Plymouth.
27,030. GLOST OVENS, J. F. and W. E. Maddock, Alsagar, Cheshire.
27,031. SPEED GEAR for AUTOMOBILES, J. B. King, Plymouth.
27,032. SHIRT COLLARS, J. Bouethrone, Liverpool.
27,033. ELECTRIC SWITCHES, C. M. Dorman, R. A. Smith, and H. G. Baggs, Salford.
27,034. ORE CONCENTRATORS, F. Esser, Barmen, Germany.
27,035. BOOT PROTECTORS, J. R. Hancock and J. Keeling, Manchester.
27,036. SUSPENDING MANTLES for INCANDESCENT GAS LIGHTS, D. McGonigal, R. F. Payne, and R. Crawford, Belfast.
27,037. PRINTING PATTERNS of LINOLEUM, H. C. Shaw, Liverpool.
27,038. STEREO-TELESCOPES, M. Berger, Jena, Germany.
27,039. SEATS for TRAM-CARS, J. Riley, Southampton.
27,040. SECURING HUBS to SHAFTS, W. H. Gordon, London.
27,041. FLUID-PRESSURE ENGINES, T. S. James, London.
27,042. SPEED and REVERSING GEAR, T. S. James, London.
27,043. FLYING MACHINES, A. H. P. Blunt, London.
27,044. CYCLES, J. D. Roots, London.
27,045. STEAM TURBINES, J. W. Smith, London.
27,046. WINDOW SASH FASTENERS. H. J. Hudson, Purfleet, Essex.
27,047. SILENT NOTE INDICATOR, B. D. Bayly and H. W. Crowther, Exeter.
27,048. TURBINES, J. B. Evans, Kingston-on-Thames.
27,049. WRENCHES and SPANNERS, A. Sharp, London.
27,050. GENERATING MOTIVE POWER, J. Hutchings, London.
27,051. SWITCH APPARATUS for TRAMWAYS, A. W. Kiddle, London.
27,052. TENNIS RACKETS, A. A. and A. E. Trimmings, London.
27,053. APPARATUS for FILING PAPERS, E. J. Passingham, London.
27,054. TRICYCLE and TRAILER, W. K. Taunton, London.
27,055. TYPEWRITING MACHINES, R. W. James.—(*The Union Typewriter Company, United States.*)
27,056. ENVELOPS, A. Debiton, London.
27,057. BURNERS for INCANDESCENT GAS LAMPS, E. Wood, London.
27,058. CABLE GRIPS for HAULAGE PURPOSES, H. Funke, London.
27,059. MOTOR VEHICLES, M. S. Napier and S. F. Edge, London.
27,060. CONTROLLING DEVICES for ELECTRIC MOTORS, B. C. Kenyon, London.
27,061. CONSTRUCTION of SUBAQUEOUS TUNNELS, D. D. McBean, London.
27,062. TRANSMISSION GEAR, J. W. T. Cadett, London.
27,063. HEATING RECEPTACLES, F. Pudney, London.
27,064. APPARATUS for "SHOOTING" GAMES, H. Künzel, London.
27,065. PNEUMATIC TIRES, G. E. Heyl-Dis, London.
27,066. TWO-STROKE INTERNAL COMBUSTION ENGINES, G. Oppenheimer.—(*A. G. R. Carlsund, Russia.*)
27,067. WALKING STICKS and UMBRELLAS, J. J. Scanlan, London.
27,068. INK ERASER or DOUBLE FOUNTAIN PEN, H. Agar, Tasmania.
27,069. TROUSER PRESS, A. E. Pusey, London.
27,070. WASHING MACHINES, W. de L. Whitney, London.
27,071. RAILWAY TRAFFIC CONTROLLING APPARATUS, C. J. Coleman, London.
27,072. TABULATING MACHINES, H. Hollerith, London.
27,073. FURNACES for ROASTING, U. Wedge, London.
27,074. EYE of CENTRIFUGAL FANS, S. C. Davidson, London.
27,075. SHELVING, J. P. Taylor, London.
27,076. MAKING MEDICINE from CARROTS, E. F. Bolt, London.
27,077. STAY for HEADS of CASKS, H. Russell, London.
27,078. HAND PAINT-SPRAYING DEVICES, W. Graaf, London.
27,079. SPRINGS, W. I. Twombly, London.
27,080. CONSTRUCTION of LOCKS, J. G. Horsey, London.
27,081. VALVES, W. I. Twombly, London.
27,082. ELECTRICAL COUNTING APPARATUS, Dollond and Co., and T. Crawford, London.
27,083. CONTROL of ELECTRIC MOTORS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
27,084. CONTROLLING MECHANISM for SELF-PROPELLED VEHICLES, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
27,085. PAPER BAGS, J. E. Bousfield.—(*P. Wood, S. Australia.*)
27,086. PROTECTIVE COVER for PNEUMATIC TIRES of CYCLES, W. P. Thompson —(*J. Albers, Germany.*)
27,087. WINDOW SASHES, J. W. Smith, London.
27,088. SAFETY MECHANISM for MINE SKIPS, J. H. Pickavance, London.
27,089. AIR MOISTENING APPARATUS, S. W. Cramer, Liverpool.
27,090. PRODUCTION of PRINTING PLATES, L. Collardon, London.
27,091. MANUFACTURE of NEW SULPHURISED DYESTUFFS C. D. Abel.—(*Akt.-Ges. für Anilin Fabrikation, Germany.*)
27,092. MANUFACTURE of YELLOW-RED COLOUR LAKES, C. D. Abel.—(*Akt.-Ges. für Anilin Fabrikation, Germany.*)
27,093. MANUFACTURE of NEW COLOUR LAKES, C. D. Abel.—(*Akt.-Ges. für Anilin Fabrikatson, Germany.*)
27,094. MANUFACTURE of RED COLOUR LAKES, C. D. Abel.—(*Akt.-Ges. für Anilin Fabrikation, Germany.*)
27,095. ELECTRIC TELEPHONY, C. A. Randall, London.
27,096. FIRE ALARMS, C. D. Abel.—(*Siemens and Halske Akt.-Ges., Germany.*)
27,097. CONTROLLING HOT WATER SUPPLY, J. C. Busby and A. E. Elmes, London.
27,098. BRACKET for AUTOMOBILE LAMPS, F. H. H. and W. F. H. Ward, and L. Blériot, London.
27,099. SPOOL WINDING MACHINES, A. Saurer, London.
27,100. MOTOR APPARATUS, Mavor and Coulson, Limited, and H. A. Mavor, London.
27,101. STEERING PROPELLERS, G. Westle, London.
27,102. GLASS CUTTING DEVICES, N. Fells, London.
27,103. CONSTRUCTION of CONCRETE WALLS, H. Eymael, London.
27,104. WEAVING LOOM, E. Saby, London.
27,105. PREPARATION of OILS, W. Loebell, London.
27,106. REGISTERING PRINTERS' FORMS, W. J. Taplin, London.
27,107. SHOE SEWING MACHINES, W. E. Lombard, London.
27,108. JAR-SEALING WRENCHES, L. D. Burlingham and H. E. Eakin, London.
27,109. SAW-SET, O. E. Lindfors and S. Borrell, London.
27,110. SPECTACLE FRAMES, J. T. Walklate, Birmingham.
27,111. AUTOMATIC DEVICE for TYPEWRITERS, H. O. St. Hill, London.

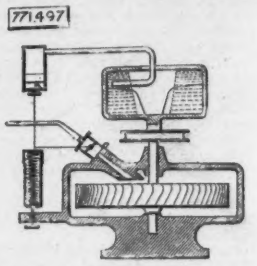
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

771,497. REGULATING DEVICE FOR MOTORS OR ENGINES, *F. Reichenbach, Charlottenburg, Germany.—Filed September 23rd*, 1903.

Claim.—In a regulating device for motors and engines, the combination with a rotary part or parts driven by the motor or engine, a liquid subjected to pressure by virtue of the rotation of said part or parts, a pipe adapted to receive said liquid under pressure,

771,497

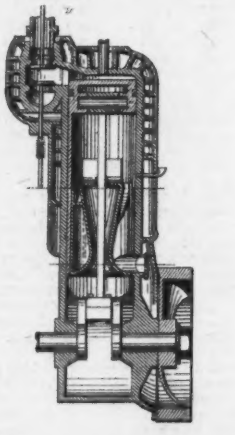


a cylinder connected with said pipe, a return pipe from the cylinder to the rotary part, a constriction in the return pipe, a piston in said cylinder, means for changing the quantity of the driving medium passing to and into the motor or engine, means for causing said piston to operate said first-mentioned means and a spring adapted to move said piston opposite to the direction of the liquid under pressure.

772,178. COOLING MECHANISM FOR EXPLOSIVE ENGINES, *F. Reaugh, Oak Cliff, Tex.—Filed May 8th*, 1903.

Claim.—(1) An engine having walls arranged within the cylinder and practically separating the interior of the cylinder from the interior of the crank case, the said walls forming spirally-disposed air passages, one of said passages leading to the interior of the cylinder and admitting air to cool the piston, the other passage leading from the interior of the cylinder, and valves commanding said passages, the air circulation through

772,178

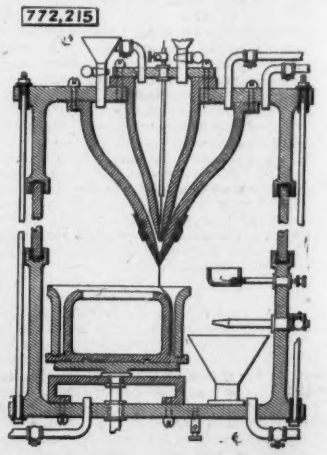


the passages being enforced by the piston movement. (2) An engine having a cylinder formed with an air-circulating passage, walls forming spirally-disposed air passages leading from the cylinder air passage into the interior of the cylinder at the outer side of the piston, and also leading from the interior of the cylinder outward, valves commanding the interior passages, the outlet of the passages terminating in an annular cavity, and a fly-wheel fan communicating with the said cavity, air circulation in said passages being enforced by the piston movement and assisted by the fly-wheel fan.

772,215. PROCESS OF MANUFACTURING GLOWERS, LUMINANTS, AND FILAMENTS FOR ELECTRIC INCANDESCENT LAMPS, *F. M. F. Cazin, Hoboken, N.J.—Filed March 2nd*, 1903.

Claim.—(1) The process of preparing luminants for incandescent lamps, consisting in squirting suitable material into the inner air-evacuated space of the bell jar of an air-exhausting apparatus, drying the so-squirted fillet by means of the rarefication of the air within the bell jar and forming the said portions into the desired longitudinal shape, substantially as set forth. (2) The process of preparing luminants for incandescent lamps, consisting in squirting suitable

772,215



material into the inner air-evacuated space of the bell jar of an air-exhausting apparatus, drying the so-squirted fillet by means of the rarefication of the air within the bell-jar, forming the said squirted material into the desired longitudinal shape and simultaneously covering the squirted material with dust. (3) The process of manufacturing fillets or glowers for electric lamps, consisting in squirting suitable material into the inner space of a bell jar, simultaneously air exhausting said bell jar and injecting dust into the bell jar to cover the squirted material.

LITERATURE.

Reinforced Concrete. By CHARLES F. MARSH, Assoc. M. Inst. C.E., Assoc. M. Inst. M.E. With 512 illustrations and Diagrams. London: Archibald Constable and Co. 1904.

IN the construction of all open web girder bridges engineers have been accustomed from their first introduction to employ different methods of trussing. Each method differed from another in the adoption of a disposition of the members constituting the web peculiar to itself. An alteration in the depth of the girder, in the number of systems of triangulation, in the panel length, in the angle of inclination of the struts and ties, and in the distribution of the loadings, will not only affect the form of the trussing, but very materially modify the value of the stresses upon it. As examples of the two extreme types may be quoted the old Warren pattern, with the bars of the web inclined at an angle of 60 deg., with no intersections, and the earliest lattice, with the angle changed to 45 deg., and with crossings so numerous that it was scarcely possible to pass the hand through the interstices or diamond-shaped meshes. These remarks will be found, with a little latitude, to apply fairly to the class of combined structures now before us. The metallic members, not necessarily restricted to any particular part of the design, together with the mode in which they are disposed in the concrete matrix, form the trussing, upon the efficiency of which depends the stability of the whole fabric. This latter proviso is all important, for it may be accepted as an axiom, that an unscientific imbedding of iron or steel sections in a mass of concrete does not necessarily constitute a true reinforcement.

At the present time there are some fifty different systems of building in ferro-concrete, many of which, it is stated in the "General Review of the Subject" in Part I., appear to have been adopted to avoid the infringement of earlier patents. Several of these systems use special sections of metal. In others ordinary plain shapes suffice, supplemented by distinctive adjustments and connections, while a third series employs both sections and methods of a novel and unusual character. In all cases the object attempted is the same, and consists in disposing the metal throughout the mass in such a manner as effectually to counteract those stresses which the concrete is unable to resist. A description, with excellent illustrations upon a large scale of forty of the total half-hundred different systems in use, is given in "Systems Employed," in Part II. The treatment of these includes only columns, beams, arches, and pipes, since most of the details of construction are related to one or the other. We select a few examples, and have endeavoured to place them in chronological order. The exact date when reinforced concrete, as an example of a novel constructive material, became known is very doubtful, but a specimen of it was on view at the Paris Exhibition of 1855. Several methods also of its application were proposed as early as the year 1861 by a French engineer, M. François Coignet. The author remarks that M. Monier was certainly the first to employ reinforced concrete in a large way. It was used for some years in France, but only to a very limited extent, as the construction was based merely on experience and practical rule-of-thumb. In 1879 Monier's system was shown at the Antwerp Exhibition, but it was not until much later that the system became generally known on the Continent.

It was also in the year 1879 that M. Hennebique built floors of reinforced concrete, and since that date has been engaged in this form of construction. He was one of the first to introduce beams of this material, and, in 1896, first brought into notice piles of the same composition. About eight years subsequently M. Bordenave came forward with his method, which is restricted to pipes, sewers, and reservoirs. Among his achievements should be mentioned the laying of the "Conduit of Bone," in Algeria. The pipes for this conduit are 23·6in. in diameter, are under a head of 56ft. to 79ft., and the total length of the service is 18½ miles. As already observed, M. François Coignet was the first to point out the advantages that would attend the combination of concrete and metal, but he did not carry his ideas into practice. His son, M. Edmund Coignet, placed before the Société des Ingénieurs Civils in 1888 his views respecting the disposition of the two materials. A further communication to the same society six years later, entitled "Au Calcul des Ouvrages en Ciment Armé avec Ossature Metallique," attracted considerable attention, and formed the point of departure of new theories and studies. M. Coignet designed an armoured concrete arched bridge for spanning the Seine, where the handsome Pont Alexandre has been erected, the preference having been given to the present steel structure.

In America and Austria many important bridges have been built on the system framed in 1892 by Professor Melan, of Brünn, in the latter country. Rolled joists and built-up girders, varying in depth, are features of this type, which lends itself with facility to articulated arches. A peculiarity of the Möller pattern, used in Germany in 1894, is that the external or face beams are straight, with a small curve at the abutments, while the internal beams are bellied. The Ocher road bridge at Brunswick is an example, with a span of 76ft. 6in., which is large for plain girders. The arch or arched rib principle is almost universally employed when the opening exceeds 50ft.

In the following chapter on "Materials," all information is afforded, and the results of experiments recorded regarding the ingredients of concrete, their relative quantities, qualities, methods of mixing, and moulding, together with tables of the resulting crushing strengths, according to the composition of the matrix. A comparison of the merits of wrought iron and steel as the reinforcing metal, leads to the conclusion that except where specially rolled sections are used, or where strong concretes are needed to resist water pressure, wrought iron possesses all the qualities required, and is frequently cheaper. It is much safer than steel where welding is permitted.

The contents of Part IV. treat of the methods employed in the erection of reinforced concrete structures, and include examples of ordinary building work, as well as more pretentious designs of an engineering character. Generally, there are three methods available for adoption. The first provides for the moulding of the different pieces, either in the open or in sheds, in advance, and for their subsequent erection when sufficiently set. In the second the whole or part of the structure may be moulded in place on timber falsework, which may be struck after the hardening of the material. The reinforcement may, in the third method, be erected, or partially erected, first, and serve to support the moulds. Any one of these working methods may be employed alone, or in combination with the others. We think that some exception may be taken to the statement that "the stresses on an unhinged arch are indeterminable." The researches of Culmann and the new methods of dealing with statically undetermined structures have removed the difficulties and uncertainties of the calculations attending them. They are no longer rejected in favour of the statically determined type. There are numerous modern examples of the latter, of which one will suffice. It is that of the Kaiser Wilhelm Bridge, spanning the Wüpper Valley, near Müngsten, in a single arch of 560ft. span, erected in 1897. Among other engineers of the same opinion, Culmann as well as Eads disputed the necessity of hinges. The latter was the designer of the famous Mississippi Bridge at St. Louis, with three hingeless arches of 518ft. in span. It is not quite correct to observe that temperature stresses are annulled in hinged arches. The question may be open to doubt with respect to the three-hinged class, but not to the double-hinged girder. The author concludes this subject with the remark that "the three-hinged type is undoubtedly the best to adopt." This is rather a sweeping assertion, considering that instances are not wanting in which the central articulation has either been wholly removed after erection, or the semi-arches riveted so firmly together as to become virtually continuous. Too great mobility is the usual reason assigned for the substitution, but, as a matter of fact, the introduction of a central hinge frequently has the effect of making the structure ricketty. The evidence of existing modern metallic arch bridges is strongly in favour of the double-hinged type.

"Calculations," in Part VI., constitute the theoretical portion of the present volume, and provide for all forms of construction, from simple slabs to arch bridges of 160ft. in span. Copious extracts are made from two French works, "Le Béton Armé," by M. P. Christophe, and "Ciment Armé," by MM. C. Berger et V. Guillerme. It is not assumed that certain hypotheses which are essential to the calculations are true, or that certain theories employed are absolutely correct. But it is maintained that, when the results of experience are kept in view, it is possible to obtain theories, based upon scientific principles, which are approximately correct, and will enable dimensions to be determined, which may with perfect safety be used in designing structures. While not altogether satisfactory, this is the limit to which every writer on the subject has attained, and, indeed, it might be asked whether in other cognate branches of design and construction we have really advanced much further.

Part VI. will, we think, hardly commend itself to readers of a purely practical bent of mind. The "calculations" are exceedingly numerous, involving the employment of seventy different algebraical symbols, over 360 separate equations, and their contents occupy 150 pages, or nearly a fourth part of the whole book. Many of the formulæ are long, complicated and laborious of computation, but they are so clearly stated and thoroughly worked out, that the results may be safely accepted by those who are not solicitous respecting the why and the wherefore of every step of the process. Examples, accompanied by illustrations, are given of a selection of structures erected in reinforced concrete, among which are mentioned three built in England. They are the Great Western Railway grain warehouse at Plymouth, a warehouse for the Co-operative Wholesale Society at Newcastle-on-Tyne, and the church of St. Sidwell's, Exeter. A description of the Nicolaieff ferro concrete lighthouse, also quoted, has appeared in our columns.*

When commenting upon the little, or it might almost be stated, no encouragement held out for the employment of reinforced concrete in England by our engineers, and architects, Mr. Marsh appears surprised that we should reject the proofs afforded by our continental and American *confrères* of the advantages of that material. It is a good many years since we commenced to reject the advantages of suspension bridges. Except for ornamental purposes, and upon a very insignificant scale, that principle is not and never will be employed in the United Kingdom. It has been tried and found wanting. It is rather curious that the reinforced system has not yet been applied to any extent worth mentioning to the construction of railway bridges. We do not quite agree with the author, save for the matter of cheapness, that brick and stone bridges are in the least inferior to those of the newer type. The book is exceedingly well got up—the general type, the printing of the diagrams, and the setting of the formulæ and the equations are excellent. Although not the first work of its kind or title to appear in the English language, it will be found highly useful to all those engaged in constructive reinforced concrete. It may be accepted as an exhaustive and complete treatise by those who wish to study and further investigate a subject with which they may possibly be but partially acquainted.

* THE ENGINEER, 27th May, 1904.

BOOKS RECEIVED.

The National System of Political Economy. By Frederick List. London: Longmans, Green and Co., 39, Paternoster-row. Price 6s.

Subject List of Works on the Fine and Graphic Arts (including Photography) and Art Industries in the Library of the Patent-office. London: Patent-office, Southampton-buildings. 1904. Price 6d.

Annuaire pour l'An 1905. Publié par le Bureau des Longitudes. Avec des notices scientifiques. Paris: Gauthier-Villars. Prix 1f. 50c.

ENGINEERS' SPECIFICATIONS.

(From a Legal Contributor.)

A CORRESPONDENT who has had considerable experience of engineers' specifications* recently drew attention to a specification which contained certain clauses of particular hardship to contractors. The following observations of a legal contributor upon specifications in general, and the legal effect of the onerous clauses to which our correspondent referred in particular, may be of value to our readers:—

Perhaps the most important point for the contractor to consider before he makes a tender upon a specification is the question whether and how far he submits himself to the arbitrament of the engineer employed by the local authority or other body who may require work to be done in accordance with the contract. It stands to reason that it is the function of the engineer employed by the employing body to look after the interests of his employers, to see that proper materials are used, and to ensure that every detail of the work shall be finished within the proper time. If he is paid by the employing body for his services in these respects, it is obviously his duty to act not as a mediator between them and the contractor, but as a partisan. While it would be wrong to cast any general aspersion upon the pure-mindedness of engineers who are employed to draw up specifications, and to see that the prescribed work is properly executed, it is clear that the contractor cannot rely upon the strict impartiality of an engineer employed and paid by the employing body, if that engineer is called upon to decide some matter in difference in relation to the construction or performance of the contract. To take a simple illustration, suppose the contract were to end up with the following clause:—"All work shall be completed to the satisfaction of the engineer, whose decision as to whether the work has been properly done shall be final." In such a case the contractor would submit himself, bound hand and foot, to the engineer. He could not even sue upon the contract until he had satisfied the engineer, unless he could show that the engineer was fraudulently withholding his assent.

According to the letter of a correspondent to THE ENGINEER, November 4th, 1904, a specification recently issued, contains the following amongst other clauses:—

(*a*) "Any dispute or difference that may arise between the council and contractor during the progress of the said works, or at or after their completion touching or concerning the said works or any alterations, additions or omissions thereto or therefrom, or as to the meaning of the contract or this specification and the conditions thereof, or as to the materials or workmanship hereby, or as to any other matter in anywise relating to this contract, shall from time to time be referred to the engineer, and his decision shall be final and conclusive."

["The engineer" here referred to was, according to a previous clause, "Mr. A. B., or other, the engineer duly appointed engineer for these works."]

(*b*) "The whole of the details are to be carefully considered and got out under the supervision and to the entire satisfaction of the engineer or his deputy, to whom the whole of the drawings will from time to time during their progress have to be submitted for approval, although such approval is not to be considered as in any way relieving the contractor from responsibility as regards suitability of design, strength of parts, or otherwise."

(*c*) "The engineer reserves for himself the power to withhold the certificates to the contractor if he considers it expedient from any cause whatever to do so without being bound to give any reason for so doing."

The contract contained no arbitration clause, which, in contracts of this nature, is usually in the following form:—

"Provided always that in case any question, dispute, or difference shall arise between the owner and the contractor as to this contract or in anywise arising out of this contract, the same shall be referred to the arbitration of two indifferent persons, one chosen by each side, and such arbitration shall be subject to the provisions of the Arbitration Act, 1889."

The advantage of insisting upon the insertion of an arbitration clause will presently be discussed. The far-reaching effect of leaving all these points to the decision of the engineer may be illustrated by reference to one or two cases.

In Scott *v.* Liverpool Corporation (28 L. J. Ch. 286) a contract for the performance of works contained a provision that if the contractor should not, according to the determination of the employer's engineer, enable the works to be completed according to the contract, the employers might put an end to the contract, and that the contractor should be paid such sum as the engineer should determine to have been reasonably earned for work actually done. The contract having been put an end to under this provision, the contractor filed a bill in equity against the employers and their engineer, complaining of undue delay on the part of the latter in awarding the amount earned by the contractor, and seeking payment of what was due upon the contract, but did not establish any case of fraud or collusion against the engineer. It was decided that the Bill was properly dismissed with costs.

In another case a conductor at the time of entering the employment of a tramways company deposited with them the sum of £5, which, together with any wages due, was agreed to be forfeited in case of any breach by him of the company's rules. It was further agreed that the company's manager was to be the sole judge of whether the company was to be entitled to retain the whole of the deposit money and wages due, and that his certificate of the cause of retention should be binding and conclusive evidence between the parties in all courts of justice and before all stipendiary magistrates, and should bar the conductor of all right to recover, under any circumstances, the monies so certified to be retained. After three months' service the conductor was discharged from his employment, and the deposit money, as well as wages due, were certified by the manager to be forfeited for non-observance of certain rules. It was decided that, in the absence of fraud, such certificate was binding, there being nothing in the agreement that was illegal or void (London Tram Co. *v.* Bailey, 3 Q. B. D. 217).

For a long time much doubt existed as to the position

* See THE ENGINEER, November 4th, 1904, page 458, letter signed by "M. I. M. E."

of the engineer in deciding such points, *i.e.*, whether he acted as the paid servant of the employer, or as a quasi-arbitrator between the employer and the contractor. The importance of this was that, if he acted as a quasi-arbitrator, he was liable for negligence neither to the employer nor to the contractor (Le Lievre *v.* Gould (1893), 1 Q.B. 491), and this was thought to give him an interest in taking care that if he made mistakes they should be in favour of the employer. The law may now be considered fairly settled by the decision in Chambers *v.* Goldthorpe, and Restell *v.* Nye (1901), 1 K.B. 624, where it was held that, in granting his final certificate, settling the respective rights of the employer and contractor, he is acting as a quasi-arbitrator, but that, in deciding matters arising during the progress of the works, he is acting simply as the employer's servant.

It is usual to give the engineer the right to order variations and omissions from the works contractor to be built, to extend the time for completion, to condemn defective work and material, to certify the money to be paid to the contractor during the execution or on completion of the works, and generally to decide all disputes between the employer and contractor. Generally speaking, too, his decision on these points is absolutely binding on the employer and contractor, and a condition precedent to any right of action upon the contract. Even where there is an appeal from his decision, very often it is merely to himself in the character of arbitrator, and there is no ground in law for holding him incapable of acting as arbitrator upon an appeal from his own decision as architect or engineer (Jackson *v.* Barry Railway Company (1893), 1 Ch. 238).

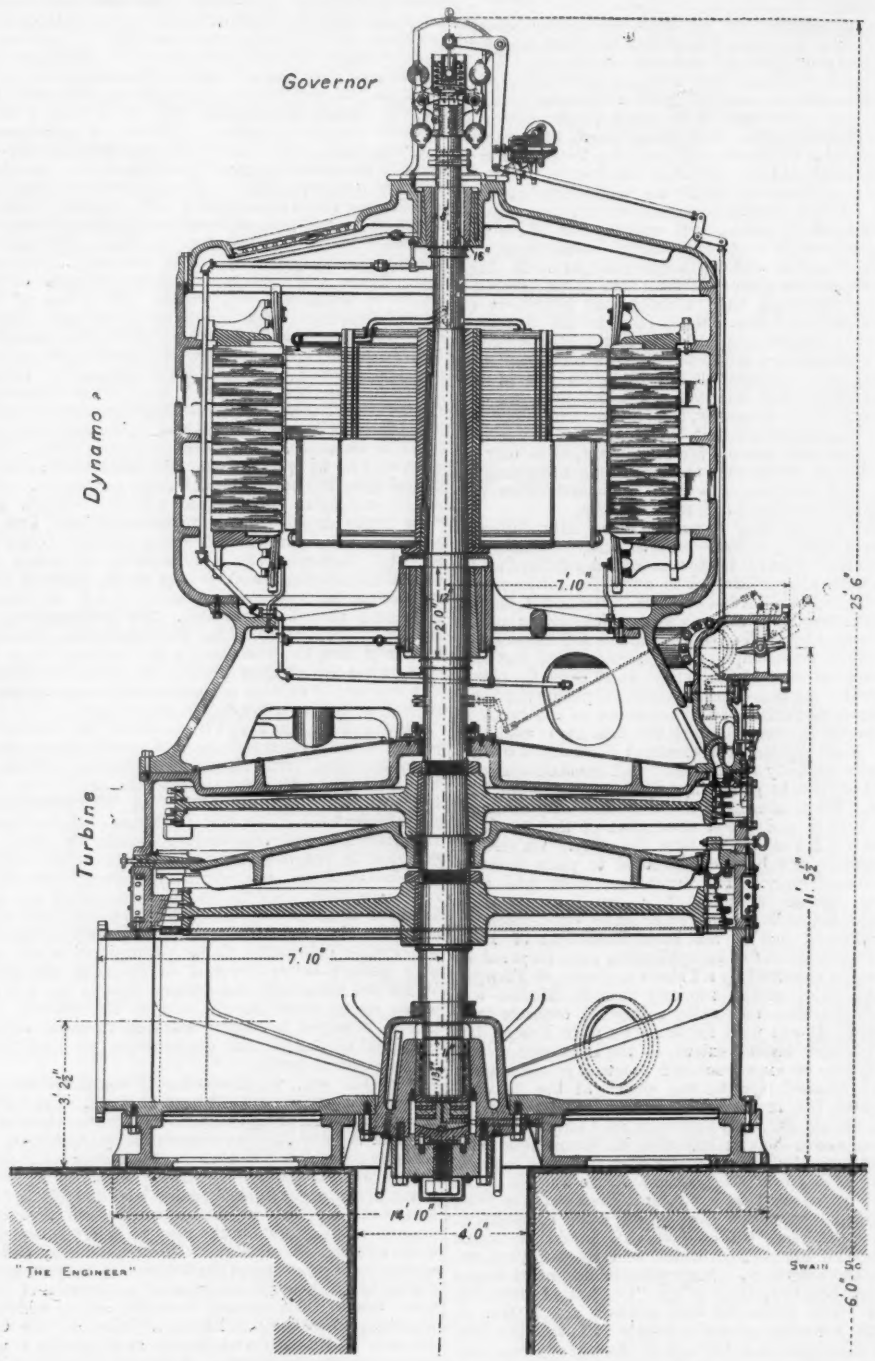
In view of these cases, it is obvious that a contractor would act exceedingly foolishly in appending his signature to any contract which contained clauses analogous to those quoted above. There is warrant for saying, however, that a Court of law might not hold all the conditions absolutely binding upon the contractor. Thus, if anything happened to the engineer named in the contract, and the employing body were to have power duly to appoint an engineer for the works; it is conceived that the contractor should have some say in the selection—in other words, a right to object to one who is to assume the position of a quasi-arbitrator, if he was obviously a partisan. In a case which was decided in 1845, the appointment of the surveyor of a railway company to act as its arbitrator in a dispute was held to be objectionable, and in a much later case the Court very properly threatened to revoke a submission, where an insurance company had the temerity to appoint its own manager to act as its arbitrator. At the same time it is conceived that unless the contractor were to make out a very strong case to the effect that the engineer was inexperienced, or likely to be biassed against him, the Court might decide even this point against him.

To those who have unfortunately been compelled to sign contracts containing a clause to the effect that contractors shall be bound by the engineer's decision, it may be comforting to know that the necessary power and authority must be conferred in the clearest possible language. In Lawson *v.* Wallasey Local Board (11 Q.B.D. 229) the plaintiff contracted to remove 10,000 cubic yards of the Mersey banks contiguous to Leacombe Ferry for £5000, and to finish the work completely under the direction and to the satisfaction of the defendants' engineer by the 1st of October, 1878, subject to such an extension of time as the engineer might think reasonable, in case a temporary staging then erected on the site of the work should not be removed within such a time as could enable the plaintiff to complete the work by October 1st, 1878. The defendants were to make monthly payments on the certificate of the engineer to the amount of 80 per cent. of the value of the work done during each month, and the balance of the sum of £5000 on the completion of the work. There was also a clause in the contract providing that if any difference should arise between the local board and the contractor concerning the work contracted for, or concerning anything in connection with the contract, such difference should be referred to the engineer, and his decision should be final and binding on the local board and the contractor. The work was completed on the 11th November, 1879, and then a correspondence took place between the plaintiff and the engineer with reference to the plaintiff's claim against the defendant board. The engineer admitted that the plaintiff was entitled to compensation for the expense caused by delay in consequence of the non-removal of the staging, and agreed to allow £15 10s. per day for thirty-eight days, but they could not agree upon the amount due to the plaintiff for extra work and other expenses. In June, 1880, the engineer sent a certificate to the Works Committee of the defendant board, stating that the work was finished to his satisfaction, and that £1065 19s. was due to the plaintiff, and the defendants sent a cheque to the value of £962 2s., that being the balance of the sum certified after making certain deductions. The plaintiff, after giving credit for this sum, brought an action against the defendants for £2489 13s. 11d. It was decided that it was not a difference concerning a matter in connection with the contract, and as to which the decision of the engineer was conclusive. In order to bind a contractor to the certificate or decision of an architect or engineer appointed by the party for whom the work is done, there must be very conclusive language in the contract. It was decided also that the documents set out in the case did not amount to a contract by the engineer, or a reference to, or award by him as to the plaintiff's claims.

In view of the difficulties which may beset those who submit to be bound by the decision of the engineer employed by "the employing body," the insertion of a proper arbitration clause in every agreement of any magnitude should be insisted upon. Apart altogether from the fact that an arbitration clause will often enable the parties to avoid harassing litigation, it may also serve to protect the contractor from having to abide by the sole

5000-K.W. CURTIS TURBO-ALTERNATOR

(*For description see page 639*)



decision of an engineer employed by the other party to the contract.

Two cases may serve to illustrate this. In the first of these a contract for the sale of locomotives provided for payment of the price, upon the certificate of the engineer that the locomotives were in perfect working order delivered at Croydon, and it was further provided as follows:—"Clause 9.—The vendors guarantee to make good any failure of the locomotive or boilers, as regards each locomotive or boiler, for a space of six months after the date of the delivery of the same, if arising from bad materials, faulty workmanship, or from the system of construction of the engines." There was also an arbitration clause to the following effect:—"All disputes to be settled by the engineer to the purchasers and the engineer to be appointed by the vendors or their umpire in case of difference." The locomotives were delivered at Croydon, but the engineer refused to certify or to give his reasons for not certifying. The vendors thereupon proceeded, under the arbitration clause, the purchasers taking part under protest. An award was given in favour of the vendors. It was decided that a dispute had arisen within the arbitration clause.

Again, the case of Foster and Dicksee *v.* Mayor, &c., of Hastings (19 T.L.R. 204), which was decided last year, makes it plain that if an arbitration clause is inserted in a contract, the jurisdiction of the engineer to act as sole arbitrator may be ousted. In that case the plaintiffs were under contract to carry out certain works for the defendant corporation. There was a clause which provided that, if any dispute should arise between the council or the engineer and the contractor as to the mode of carrying out the work or the interpretation of the contract or otherwise in relation thereto or in settlement of the account, the same should be referred to two arbitrators, subject to the provisions of the Arbitration Act, 1889. The contract also contains a clause to the effect that if, in the judgment of the engineer, the work "is improperly conducted or sufficient dispatch is not used about it, the council or the engineer shall have the power, without prejudice to the contract, to dismiss the contractor and his workmen after giving a certain length of notice." Delay having arisen which rendered it desirable for the contractors to be dismissed, the engineer gave the necessary notices. The contractors, however, resented this treatment, and applied to the Court for an injunction, arguing that it was not competent for their employers to dismiss them in this summary way. A judge of the Chancery Division, who tried the case, held that the arbitration clause overrode the authority of the engineer, and that the question whether the contractors had been guilty of undue delay was to be settled by arbitration.

Finally, the greatest care should be exercised in selecting an arbitrator. It cannot be made too plain that where a dispute is referred to arbitration by consent of the parties, neither party can make any objection to his award, except in certain rare cases. The law upon this question was well laid down by Mr. Justice Williams, in the case of Hodgkinson *v.* Fernie (3 C.B., N.S., 189), where he said:—"The law has for many years been settled, and remains so to this day, that, where a cause or matters in difference are referred to an arbitrator, whether a lawyer or a layman, he is constituted the sole and final judge of all questions, both of law and fact. Many cases have fully established that position where awards have been attempted to be set aside on the ground of the admission of an incompetent witness or the rejection of a competent one. The Court has invariably met those applications by saying, "You have constituted your own tribunal; you are bound by its decision. The only exceptions to that rule are cases where the award is the

result of corruption or fraud, and the one other which, though it is to be regretted, is now, I think, firmly established, namely, where the question of law necessarily arises on the face of the award, or upon some paper accompanying and forming part of the award. Though the propriety of this latter may very well be doubted, I think it may be considered as established."

One or two illustrations serve to show how rigorously the principle of this decision has been applied:—(*a*) In the case of Steff *v.* Andrews (2 Mad. 6) it was decided that if parties submit to an arbitrator a bare point of law, and he gives an erroneous decision, his award is nevertheless binding. (*b*) In Greenwood *v.* Brownhill (44 L.T. 47) the Court refused to allow a party to impeach the award of an arbitrator, on the ground that the legal effect of it was different to what he supposed it would be. (*c*) It cannot be alleged as a ground for setting aside an award on a reference by consent that it is contrary to the evidence (*re* Bradshaw, 12 Q.B. 562).

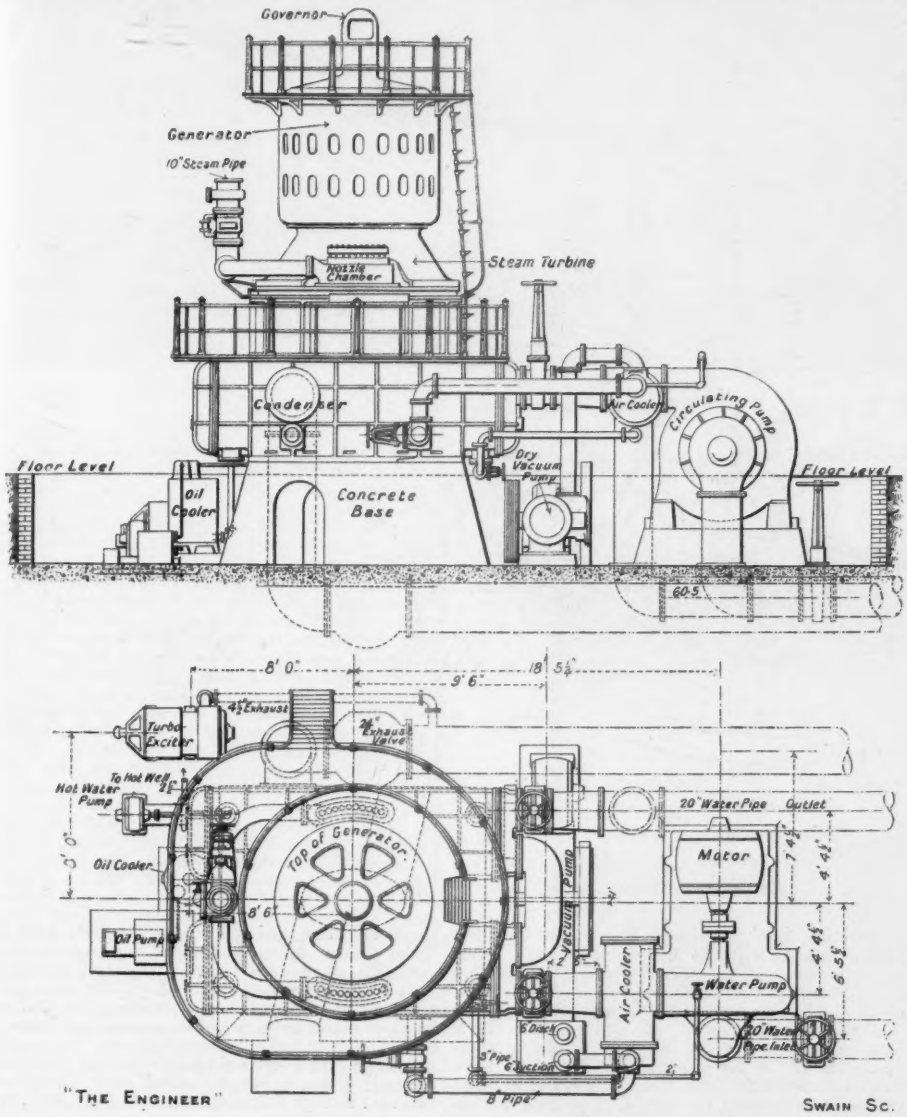


Fig. 6—2000-K.W. CURTIS TURBO-ALTERNATOR

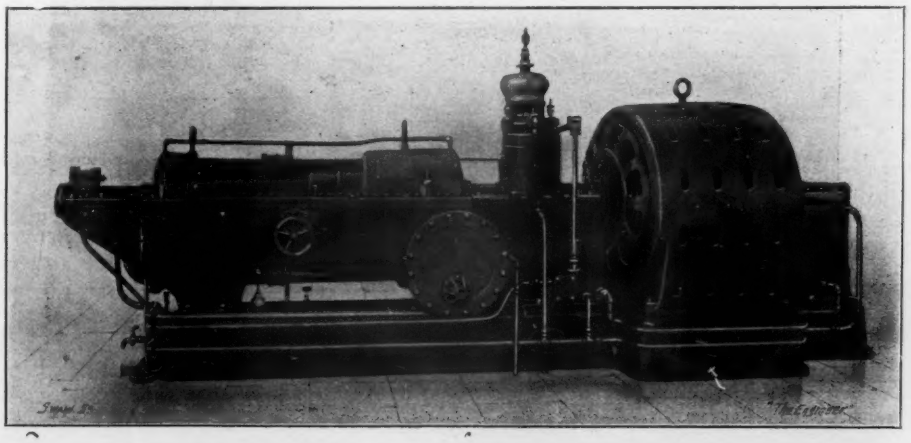


Fig. 7—600-H.P. PARSONS-WESTINGHOUSE STEAM TURBINE

ACCORDING to the approximate traffic return for November, the Manchester Ship Canal's receipts amounted to £38,361, as compared with £37,199 in November last year. For the eleven months the receipts have totalled £370,037, or £18,450 more than in the corresponding period of last year.

THE INTERNATIONAL EXHIBITION AT ST. LOUIS.

XXV.*—STEAM TURBINES.

THE Curtis steam turbine, exhibited by the General Electric Company, has a vertical shaft, and is of the four-stage type. It is rated at 2000 kilowatts, and has a maximum capacity of 4000 kilowatts, with steam at 175 lb. and a vacuum of 28in. It runs at only 750 revolutions, and above it is a 2000-kilowatt, 25-cycle, 6600-volt, three-phase generator. The turbine and generator are mounted on a Worthington surface condenser having a cooling surface of 8000 square feet and furnished with an air cooler. The circulating water is handled by a 20in. horizontal volute pump of 125 horse-power, and the hot water by another volute pump of 7½ horse-power delivering to an open heater. This latter pump is placed several feet below the condenser and regulates itself automatically, requiring neither floats nor valves, while there is no liability of vapour binding, as sometimes occurs in direct-acting pumps. The 50-horse-power, rotative, dry-vacuum pump has a 22in. air cylinder and 18in. stroke; it is driven from an electric motor by a Renold silent chain belt. The exciter unit consists of a 25-kilowatt, non-condensing, horizontal Curtis turbine, directly connected to a two-pole, 125-volt generator, and running at 3600 revolutions. The pressure on the step bearing, which supports the weight of all the revolving parts, is 425 lb. per square inch, and oil is supplied to the step and guide bearings by a duplex Worthington pump, 4½in. × 4½in. × 4in., capable of circulating four gallons of oil per minute. A vacuum of about 27in. is maintained. Fig. 6 shows the arrangement of the turbine and auxiliaries. It is the first one built on a condenser base, and a similar machine, but without condenser, is shown on page 638. Two Curtis turbines of 5000 kilowatts, with condenser bases, have been erected at the power station of the Boston Edison Company.

The operation of the Curtis steam turbine is described as follows:—

"Velocity is imparted to the steam in an expanding nozzle, so designed as to efficiently convert nearly all the expansive force between the pressure limits used into velocity in the steam itself. After leaving the nozzle, the steam passes successively through two or more lines of vanes on the moving element, which are placed alternately with reversed vanes on the stationary element. In passing successively through these moving and stationary elements the velocity acquired in the nozzle is fractionally abstracted, and largely given up to the moving element. Thus, the steam is first thrown against the first set of vanes of the moving element, and then rebounds alternately from moving to stationary vanes until it is brought nearly to rest. By this means a high steam velocity is made efficiently to impart motion to a comparatively slowly-moving element. The nozzle is generally made up of many sections adjacent to each other, so that the steam passes to the wheels in a broad belt when all nozzle sections are in flow.

"The governing is effected by successive closing of nozzles and consequent narrowing of the active steam belt. The cut—Fig. 8—shows part of the nozzle open, and part closed, the arrows showing space filled by live steam. In the process of governing, the nozzles of the later stages may or may not be opened and closed, so as to maintain an adjustment proportional to that of the first stage, which is always the primary source of governing. Some improvement of light-load economy may be effected by maintaining a relative adjustment of all nozzles; but in many cases the practical difference in economy is not great, and automatic adjustment of nozzle opening in later stages is dispensed with in the interest of simplicity. In some machines an approximate adjustment is maintained by valves in later stages, which open additional nozzles in response to increases of pressure behind them. These are used as much for limiting the pressures in stage chambers as for maintaining the light-load economy."

The speed of these turbines with variable load is controlled by the opening and closing of the nozzles, the number of nozzles corresponding to the load being always open. A centrifugal governor attached to the top of the shaft operates levers connected to the valve mechanism. Each valve communicates with one or more nozzle sections, and is connected to a long piston so that it can be operated by steam. The motion of each of these pistons is controlled by a small pilot valve which is worked from the governor, and regulates the steam supply to operate the main valve.

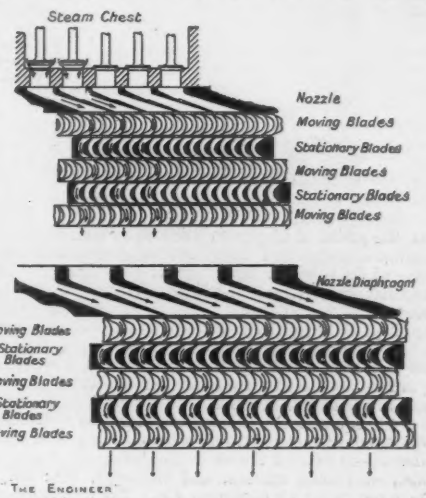


Fig. 8—DIAGRAM OF CURTIS TURBINE

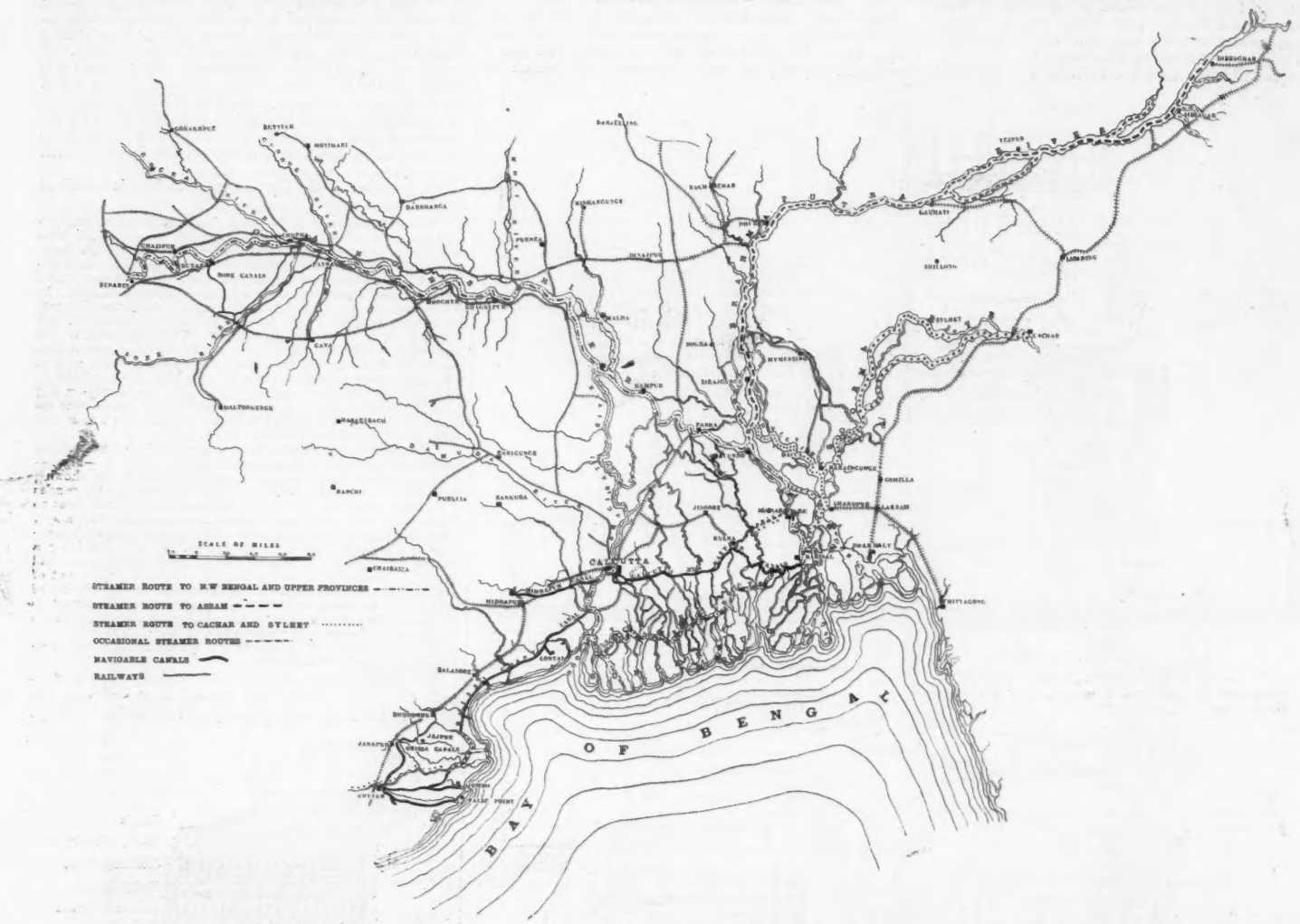
The Parsons steam turbine, which has been taken up in the United States by the Westinghouse Company, and somewhat modified under the name of the Parsons-Westinghouse turbine, is too well known to need description of its mechanical design. It is of the horizontal, multi-stage type. The rotor consists of a cylinder of three or more diameters, and having its periphery fitted with rings of radial vanes. The stator is a casing enclosing the rotor and having circular rows of stationary radial blades having a reverse pitch to that of the vanes on the rotor. The steam expands in passing through the vanes on both the rotary and stationary element, and the end thrust is resisted by balance pistons of diameters equal to those of the rotary element and revolving with it.

The Parsons-Westinghouse steam turbine at the St. Louis Exhibition—Fig. 7—is of 600 horse-power, and runs at 3600 revolutions per minute; it takes steam at 150 lb., and carries a vacuum of 27in. to 28in. On its shaft is the revolving field of a 400-kilowatt generator, delivering a 60-cycle three-phase alternating current at 440 volts, 7200 alternators, with 524 ampères at the terminals. The surface condenser is of the Worthington make, with 1500 square feet of surface, and the condensed steam collects in a 22in. hot well, from which it is pumped to the boiler feed by a motor-driven volute centrifugal pump with a 1¼in. discharge pipe. As it is necessary to free the condenser from air in high vacuum work, there is a rotative single-stage dry vacuum horizontal pump, 6in. by 10in. by 10in. Before the air reaches the pump it is cooled, and has its moisture condensed and removed by a tubular air cooler placed in the cold water inlet of the condenser, the condensed vapour flowing to the hot well.

The steam is admitted to the turbine in short puffs or

* No. XXIV. appeared December 16th.

NAVIGABLE CANALS AND STEAMER ROUTES IN BENGAL



jets, the period of admission being controlled by a centrifugal governor geared from the turbine shaft and adjustable while running, thus enabling alternators to be successfully operated in multiple. While the turbine is rated at 400 kilowatts, it has a guaranteed overload capacity of 50 per cent., and an actual overload capacity of 75 to 100 per cent. The unit is 18½ft. long, 7½ft. wide, and 4½ft. high, covering a floor space of 138·6 square feet, or 292 square feet, including the passage ways and auxiliaries in the basement. This gives a floor space of 0·258 or 0·545 square feet per electric horse-power. The steam pipe is 5in. diameter, turbine exhaust, 20in.; atmospheric exhaust—in case of the condenser being out of service—12in.; condenser, suction, and discharge, 8in.; hot well discharge, 2½in.; air discharge, 4in. The unit is mounted on a reinforced concrete floor on 12in. rolled joists, and beneath this are the auxiliaries.

The De Laval Steam Turbine Company has six of its steam turbines at the Exhibition. Its own exhibit includes a 55 horse-power turbine driving a high-pressure De Laval centrifugal pump, a 55 horse-power turbine driving a low-pressure centrifugal pump, and a 20 horse-power turbine driving a dynamo, which supplies current for a motor-driven pump. In the Electricity Building is a 300 horse-power 200 kilowatt turbo-generator, taking steam at 150 lb., and running at 900 revolutions; at the Philippine exhibit is a 20-kilowatt turbo-generator, and in the gas machinery section of the Manufactures Building is a 10 horse-power De Laval turbine, directly connected to a Sturtevant blowing fan. The De Laval turbine is of the single-wheel type, the steam is expanded in a nozzle to obtain the maximum velocity, due the pressure, and on account of the high velocity of the steam it is necessary to run the wheel at very high speed, which in turn necessitates the use of speed-reducing gears to connect the turbine shaft with the dynamo shaft.

A curious little appliance among the exhibits is a steam jet or impact wheel fitted on a portable plant of the Star Drilling Company for drilling wells; it operates a miniature centrifugal pump for washing out the drill hole.

INLAND NAVIGABLE WATERWAYS OF BENGAL.

IN the early part of the fifteenth century improvements were commenced in the navigation of English rivers, particularly on the Thames, the Ouse, and the Lea. Leonardo da Vinci invented the water lock towards the end of that century, and in 1572 the first boat canal, called the "Exeter," was constructed in England. In India the great rivers, notably the Ganges, the Indus, the Irrawaddy, and the Bramaputra, had been navigated for ages, before any work which could be called a navigable canal was constructed. The first work of the kind in Bengal is believed to have been the tidal canal, called Tolley's Nullah, which was constructed by a Major William Tolley about the year 1776 under a deed executed by Warren Hastings, Richard Barwell, and Phillip Francis. This deed set forth that Major Tolley was to cut a navigable channel from the Hoogly to the Salt Water Lake at "his own proper costs and charges" on condition that certain concessions were made to him; he, in return, "yielding and paying, therefor, yearly and every year . . . the yearly rent of one peppercorn." It is curious to notice that one of Major Tolley's arguments in favour of his scheme was that "the town of Calcutta would be better secured, as it would be on an island, and consequently, by a proper disposition, the reduction of it would be more difficult." This view does not seem to have found favour with the military authorities. The Fort, which still stands in Calcutta, was at that time under construction, and the chief engineer of it said that one portion of the canal "will most assuredly be prejudicial to the fortification, as it would not only completely answer the purpose of a parallel, ready-made for an enemy in case of a siege, but would also afford them a very secure and commodious place to shelter their boats, and to land all military stores and provisions necessary for the prosecution of it." However, the canal was made, and was most successful; both Major Tolley and his widow deriving a large revenue from it until 1804, when it was taken over by the Government.

At that time the Eastern Canal was the name given to a shallow and tortuous channel, nearly dry at low water, by which native boats passed through the salt water lakes to a point about two miles from Calcutta. This canal was little more than a series of pools connected by a shallow channel; it was, in fact, a natural creek, which in 1737 extended through Calcutta, from a point not far from the present General Post-office, and passed down Creek Row and through the part which to this day is known as "Dingee Bagan," or the place of boats. During the cyclone of the 11th October, 1837, a large ship is said to have been carried by a wave out of the Hoogly and wrecked in this creek. At the beginning of the last century the greater number of the large boats which arrived in Calcutta from the Eastern districts were unable to get nearer the town than the centre of Tolley's Nullah, and the goods had either to be carted several miles or sent in small "Dinghees" through the Eastern Canal.

Fig. 1—A NAVIGATION CANAL IN BENGAL

In 1810 this Eastern Canal was improved up to the margin of Calcutta, but had then no connection with the Hoogly; it was connected with that river at Chitpore about 1830, chiefly in consequence of the exertions of Major Schalch, and some of the other channels leading from Chitpore eastwards were either improved or freshly excavated. A lock was also built on the Hoogly bank at that point in 1838. These improvements added immensely to the convenience of the boat traffic, which rapidly increased, and soon completely blocked the canal. In 1844 the Military Board, which at that time controlled the public works of India, assessed the gross surplus profits of these canals at nearly 30 lakhs of rupees. But, previously to that, the many natural channels on the northern margin of the Soonderbuns had been in many parts connected by artificial channels, and a comparatively direct route was opened up from the Hoogly at Calcutta to Khoolna and Burrisal. By this route the trade of Eastern Bengal, and, at certain times, of Northern Bengal also, found its way to the capital. In 1859 a loop line near Calcutta was opened to relieve the congestion of the boats, which completely blocked the older route. In 1881 a lock at the eastern end of this loop was built, and the canals immediately contiguous to Calcutta were no longer under tidal influence, and were consequently comparatively free from silt. The older lock at Chitpore, on the bank of the Hoogly, was replaced by a much larger one in 1882. In 1897 two locks further east were added, and other improvements made. This system of canals, including natural navigable channels on the line of route, is now 735 miles in length. In the eighties the traffic on these canals aggregated about four millions sterling a year, it is now about three and a-half millions. The canal has proved a profitable one to Government, the net revenue, until 1890, was never less than 4 per cent., and often 6, 8, and even 10 per cent., but, since that, the heavy expenditure incurred on improvements has reduced the net revenue to about 2 or 3 per cent. only. The chief goods imported into Calcutta by this Eastern route are rice, jute, and firewood.

The water-borne traffic of Northern Bengal, and that coming down the Ganges from Upper India, finds its way, during the rainy season when the rivers are high, down the Ganges, the Bhagiruttee—or one of the other Nadia Rivers—and the Hoogly, to Calcutta. When the Bhagiruttee becomes choked by sand banks in the dry season, the traffic has to pass down the Ganges, past Goalundo to Burrisal, and then by the Eastern Canals to Calcutta.

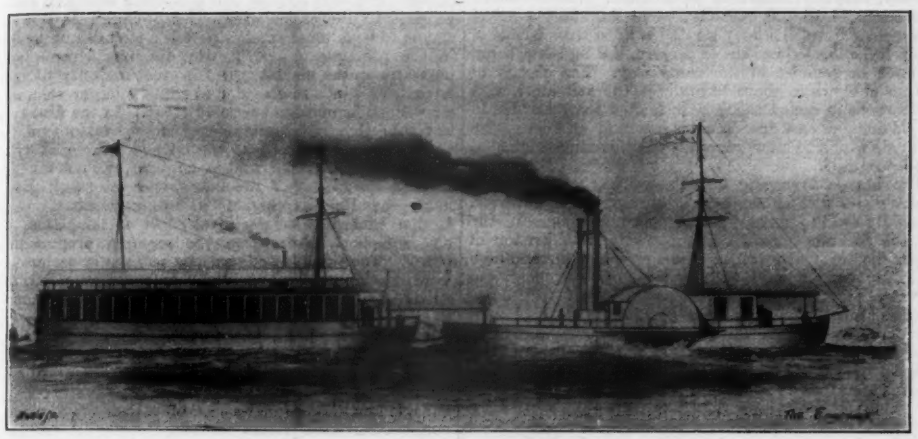


Fig 2—STEAMER AND ACCOMMODATION BOAT

This route is three or four hundred miles longer than that by the Bhagiruttee, and far more dangerous to the boats. It was proposed long ago to make a canal from the Ganges at Sahibgange to the Hoogly near Ranaghat, so as to keep the shorter route open during the whole year, but it was never made. The traffic passing by the Bhagiruttee route is now valued at about one and a-quarter million sterling annually. It has decreased greatly since the eighties, when it was about two to two and a-half millions sterling.

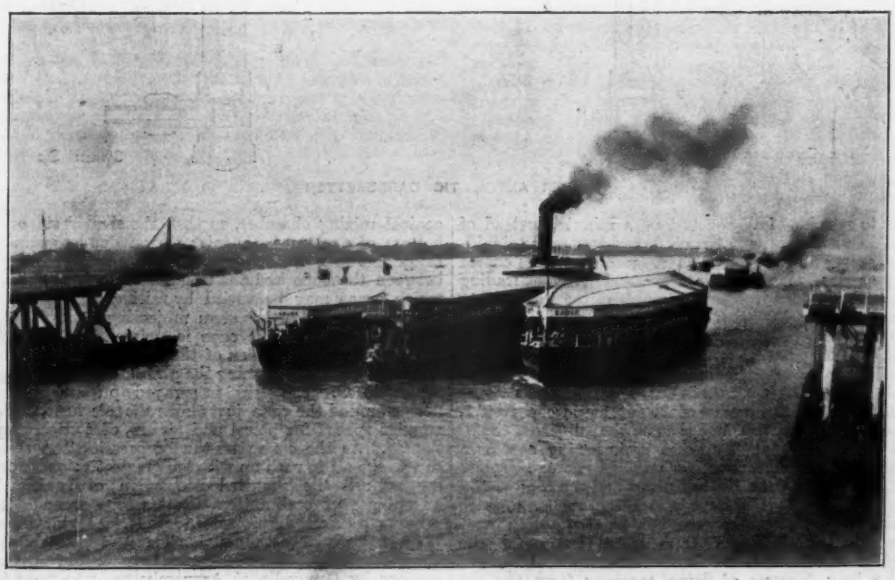


Fig. 4—STEAMER "TEGRA" AND FLATS IN THE HOOGLY

The water-borne traffic from the districts of Midnapur and Orissa, lying to the south of Calcutta, is carried by the canals, shown in the map, to the Hoogly. The Midnapur Canal is entirely artificial. The route from Cuttack, by the Orissa Canals and the Coast Canals, is mainly artificial, but runs partly through natural channels.

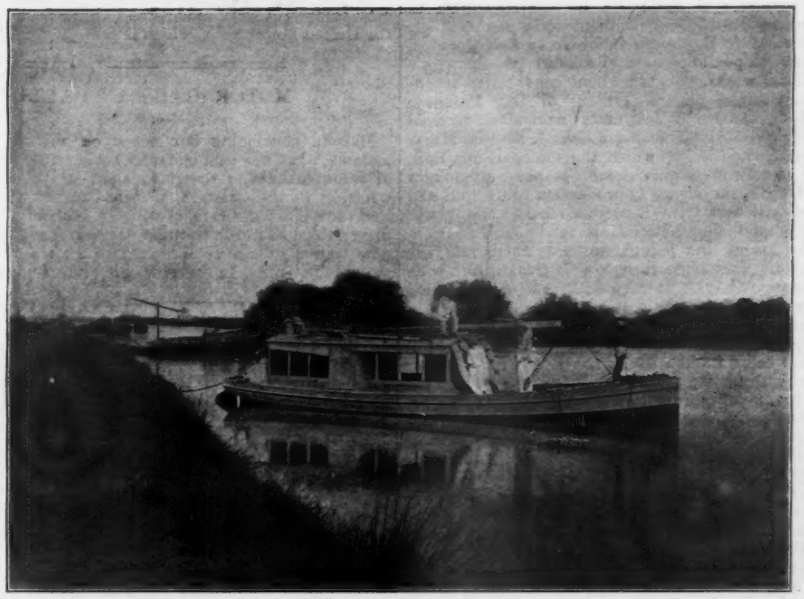


Fig. 3—OFFICER'S INSPECTION BOAT—BENGAL CANAL

The traffic on these routes, passing to and from Calcutta, is now about one million sterling a year; it has shown a marked tendency to decrease since the opening of the Bengal Nagpur Railway a few years ago.

In addition to the canals which have been described there are 218 miles of artificial navigable canals in Behar, in Upper Bengal; but these only serve local needs, and do not directly feed the Calcutta trade, or only to a small extent.

The artificial canals of Bengal, however, are of far less importance to the trade of the province than the magnificent rivers which bear a vast volume of goods to Calcutta, both in the Old World native craft and in the large steamers and flats of the several steamer companies. The map on page 640 shows the main routes.

Steamers proceed from Calcutta to Cachar and Sylhet by the Sunderbun channels, the Megna, and the Soorma; to Assam through the Sunderbun channels and the Brahmaputra; to North-Western Bengal and Behar, in the rainy season when the rivers are full, by the Hoogly, the Bhagiruttee, and the Ganges; to the Upper Provinces, beyond the limits of Bengal proper, by the same route and the Gogra River. On all these routes there is ample water for some four months in the year, but for the remaining eight months the navigation of some of them is often difficult, and in some cases impossible, owing to the small depth of water in the channels. The Bhagiruttee, for instance, is impassable for eight months in the year, and during that time all steamers and any boats which draw more than a foot or eighteen inches of water must pass round by the Sunderbun route—which is some 400 miles longer—to reach the upper parts of the Ganges. A project for the improvement of the Bhagiruttee is now under the consideration of the Indian Government. It is believed that by the employment of two or three large dredgers, such as those which have worked wonders on the Mississippi, it would be possible to open up the Bhagiruttee for navigation all the year round. No doubt the expense would be heavy; but there is, probably, no other place in the world which offers such striking opportunities for improving the water carriage to a vast agricultural district. The valley of the Ganges is unrivalled in fertility. A tract of agricultural land, which may be estimated to be 50,000,000 acres in area, would be brought 400 miles nearer its sea port, for eight months in the year, and those the months when the surplus produce is largely carried to Calcutta, if the channel of the Bhagiruttee were improved.

The Honourable East India Company was the first to organise steam navigation on the Bengal rivers, and the enterprise proved one which was not only an advantage to the trade of Bengal, but a very profitable one to the Government. In the time of Lord William Bentinck, in 1834, steam traffic was greatly developed and a regular line of steamers worked between Allahabad and Calcutta. At that time English coal stood at about 30s. a ton in India, and it was fortunate for the enterprise that Indian coal was discovered in Bengal coalfields at about the same time. This coal, although inferior to the English fuel, was fully 25 per cent. cheaper delivered on the boats. The first steamers had a speed of only six to seven miles an hour; they were about 120ft. long and 22ft. beam, with engines of 40 to 90 nominal horse-power. In the rains, when the Bhagiruttee was open, these steamers took about twenty days from Calcutta to Allahabad, and eight days on the downward journey. In the dry season, when they had to go round by the Sunderbun channels, the up journey took about twenty-four days, and the down journey fifteen. Cabin passengers were charged £30 for the whole distance, and goods about £6 per ton of 40 cubic feet, but the rate bid at auction sometimes reached £20 a ton measurement. In those days the same steamer never conveyed both passengers and goods. Passengers were taken in a barge termed an "accommodation boat" which was towed behind the steamer, as shown in Fig. 2.

Goods were carried in the same way, but in an ordinary freight boat or "flat." The twin vessels were linked to each other, at the stern and bow respectively, by a flat

team which acted as a strut between the two, and also as a means of communication between the two vessels.

Until 1844 the East India Company alone ran steamers on the Bengal rivers, but in that and the following year two companies were formed for establishing and running a line of iron steamers for freight and passengers between Calcutta, Mirzapore, and Allahabad. The Patna, a steamer belonging to one of these companies, which was constructed in Millwall, and put together in Calcutta, made her first voyage to Mirzapore in September, 1846; and the local Press had notices of "rapid" passages made in 11½ days. Since those days several companies have been formed, and there are now some 200 river steamers and a large number of flats and barges, having an aggregate capacity of some 160,000 tons working on the Bengal rivers. These are in many cases fitted with search-lights with the aid of which they navigate at night on some routes. Usually, the flats are taken alongside the steamers, as shown in Fig. 4. It is interesting to compare this with the old steamers of 1844.

The importance of the water-borne trade, which reaches Calcutta by the canals and rivers, is clearly demonstrated in the last "Report of Trade Carried by Rail and River in Bengal," where it is said that "of the total trade of Calcutta with Bengal and other provinces, more than one-half, estimated by value, is carried by river; and the river-borne trade of Bengal with other provinces—including the trade with Calcutta—exceeds one-third of the whole inland trade."

THE IRON AND STEEL INSTITUTE.

THE MARYLAND STEEL COMPANY'S WORKS, SPARROW'S POINT.

In the progress of the party from Philadelphia to Washington a detachment of about forty members left the main train at Baltimore in order to visit the steel works and shipbuilding establishment at Sparrow's Point. These works, situated about nine miles south-east of Baltimore on the estuary of the Patapsco River, close to the outlet main navigable channel from Baltimore to the sea, are owned by the Maryland Steel Company, in which the Pennsylvania Railroad and the Pennsylvania Steel Company are jointly interested, the main objects of production being rails and other sectional bars from Bessemer steel, while plates and other shipbuilding material are made for the open-hearth furnace at the parent works at Steelton. The plant includes four blast furnaces, 83ft. high, 19ft. wide in the boshes, and 12½ft. in the hearth, making low silicon Bessemer iron from Cuban ores, with small additions of Lake Superior hematites and pyrites residues from chemical works, with an average yield of 60 per cent. The Cuban ore, although somewhat slowly reducible, is associated with fusible silicates to such an extent as to reduce the amount of fluxing stone to that necessary for fluxing ash and sulphur in the coke, with a corresponding reduction in the amount of slag made. Blast is supplied through eight tuyeres and the hearth and boshes are protected by an elaborate system of bronze coolers arranged in thirteen systems of rings extending from the top of the boshes to below the tuyeres, with one series filling the pillars in the wall between the openings of the latter. The multiplicity of joints due to the coolers is attended with a certain amount of gas leakage, the outline of many of the cooling boxes being defined by flickering sheets of blue flame, which, however, are said to have no appreciable effect upon the working of the furnace. The blowing plant, furnishing blast at about 10 lb. to 12 lb. pressure, includes six groups of twin engines of 2500 horse-power, with superposed vertical steam and blowing cylinders connected by a walking beam to a fly-wheel behind, an arrangement that avoids the great height of the ordinary direct-acting engine. The steam and blowing cylinders are respectively 44in. and 84in. in diameter, with a stroke of 5ft., giving a blast pressure of 12 lb. to 15 lb. Each pair of engines occupies a floor space of 41ft. by 29ft., and is 30ft. high. The weight, including a 36-ton fly-wheel, is about 360 tons. The same engine-house contains two Bessemer blowing engines having horizontal steam and vertical blowing cylinders. The blast is heated in Whitwell stoves 22ft. in diameter, three to each furnace, the temperature being about 1100 deg. Fah.

With magnetic ore the make averages 325 tons per day, with a coke consumption of 21 cwt. per ton, but with soft red hematite the make is increased to 400 tons, and the coke consumption reduced to 18 cwt. or 18½ cwt. The greater part of the fuel is prepared on the spot from a mixture of West Virginia and Pennsylvania coal in a battery of 200 Otto Hilgenstock ovens, with air regenerators and bottom gas ovens 43ft. long, holding 9½ tons of coal, which is coked in twenty-six to twenty-nine hours. The coal, brought by barges from Baltimore, is lifted by a combination of grabs and bucket carriers into a large hopper box movable along the tops of the battery, having four funnel spouts corresponding to the charging holes of the oven. The whole of the gas is passed through condensers and scrubbers for the removal of tar and ammonia; but the portion given off during the first seven hours is treated apart, and sent away, under a pressure of 8 lb., to the gasworks at Baltimore, where it is subjected to further purification for the removal of sulphur before passing it into the ordinary town supply mains. About four and a-half millions of cubic feet of 14 to 16 candle-power gas are supplied daily. The price realised is about one shilling per thousand cubic feet. The finished coke is received in an open-sided bogey wagon of triangular section with the point downwards, which is removed to one end of the range of ovens and quenched by drenching with a large quantity of water, which runs off through the openings in the sides. The coke yield is 70 per cent. on the weight of coal charged. The 200 ovens are about equal to the supply of the three furnaces in blast, and producing 7000 tons of pig iron per week.

The bulk of the metal from the blast furnaces goes directly to the steel works, but the Sunday iron is remelted in cupolas, both being passed through a mixer of 120-tons capacity, heated by an oil flame. The Bessemer converters, of 18 tons capacity, are of the straight-nosed "haycock" form, the body section is lined with blocks of a quartzose mica slate, cut to pattern, the bottoms being rammed in ganister in the usual way. The charge of 16 tons is blown in about 16 minutes, the rail steel, with 0·6 carbon, is recarburised, with melted spiegel added in the ladle, and cast into moulds running on bogies, this method, which is now generally used, having originated at these works.

The ingots, averaging 6200 lb. weight, are heated in soaking pits with an auxiliary gas firing, which, however, is mainly used to maintain a neutral atmosphere in the pit, the consumption of coal being only 18 lb. per ton of ingots heated. The rail mill includes a 36in. two-high reversing cogging mill, with hydraulic bloom shear, and elevator for crop ends delivering directly into railway wagons; two stands of three-high 26in. rolls, each with four grooves, and a finishing pair with a single groove. The ingot, with a base 21in. by 20in. gives five 33ft. rail lengths of 100 lb. to the yard. The yield on the ingots treated is as follows:—

1·5	Waste in soaking pit
8·0	Crop ends of blooms
2·5	Crop ends of rails
11·0	Defective and wasters
87·0	Perfect rails
100·0	

The maximum output realised is 2250 tons of ingot reduced to blooms and 1800 tons of finished rails. During the visit the mills were at work on soft flat-bottomed rails for the Canadian Pacific Railway.

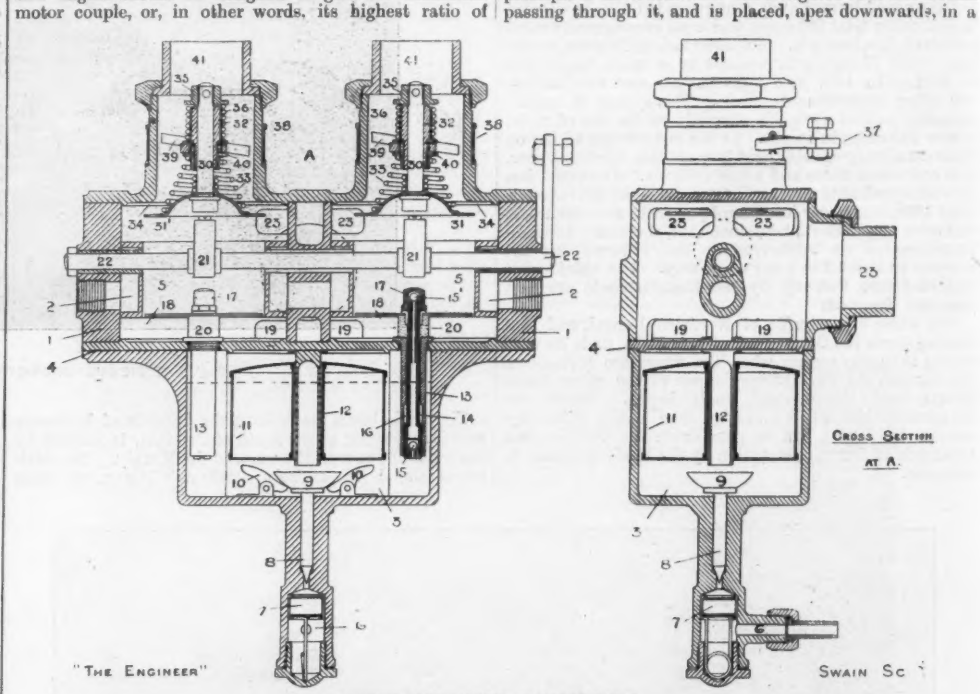
In the large shipyard adjoining the steel works the most important work in hand was a large floating dock for the United States navy, which is going to Manilla.

MOTOR CARS IN PARIS.

No. III.*

Before concluding our notes on motors, we may instance what was said last week concerning the tendency of some makers to revert to short-stroke engines by referring to the practice of the Canstatt Company in their new Mercedes cars, of which a description has just been published in the German papers. The fact that this new engine should be designed to give its maximum motor couple, or, in other words, its highest ratio of power to speed, at 1400 revolutions a minute, instead of at 1100 revolutions as in the old types, is of some significance, seeing how much the Mercedes designs are copied by other foreign makers. Nevertheless, the leading French firms do not seem disposed at the moment to follow this example, and return to a practice which they abandoned two years ago, although it may be expected to accentuate the movement among many of the smaller firms in favour of lighter engines, running at a higher angular velocity. It is certain that this question has been modified by the introduction of the automatic carburetter, whereby the motor runs under somewhat different conditions than formerly. By these carburetting devices a constant and homogeneous gas mixture is obtained, and the explosion is nearly instantaneous and the combustion fairly complete at whatever speed the motor may be running. Whilst there can be no question that an appreciable lapse of time is necessary for the complete combustion of the charge, as is proved by the long tongues of flame escaping from the exhaust pipes of engines on racing machines, yet for all practical purposes a proper mixture may be regarded as an explosible gas, which allows of engines giving a greater efficiency at higher angular velocities than was the case when makers found it desirable to abandon the short-stroke motor.

As the running of the motor depends so much upon keeping the gas mixture in its right proportions under all variations of suctional effort, temperature, and air density, it is only natural that particular attention should be paid to the carburetter. Every device now in use claims to be automatic, and there is a singular uniformity in the principle underlying the different types of carburetters on the market. In the great majority of cases an extra air inlet is provided to admit a larger volume of air with an increasing suctional effort. In the first types of carburetters which aimed at giving a constant mixture the supplementary air port was opened and closed by the governor. These apparatuses, however, did not take into account the inertia of the liquid, with the result that at low speeds the "depression" in the carburetter, or rarefaction caused by the suctional effort of the piston, was not sufficient to draw up the required proportion of petrol. Then was introduced the automatic carburetter, in which the suctional effort was exercised equally on the petrol jet and on a light metal disc held up by a spring to admit the air, as in the old Ader carburetter. This type has been abandoned, but a modification of it is to be found on the Westinghouse-Schmid car, where the air inlet is covered by a grid plate with the openings filled by light copper strips, which open more or less according to the suctional force. The use of rubber diaphragms in conjunction with pistons covering the supplementary air inlets has not proved so satisfactory as had been expected, and there are now very few carburetters designed on these lines. All these attempts to give a greater sensitiveness to the apparatus did not overcome the objection that the inertia of the liquid prevented the necessary quantity of petrol being drawn up through the fine nozzle under a weak suctional effort, so that at low speeds there was much more than the required proportion of air. The theory of the cone then attracted attention by the success of the Sthenos apparatus at the trials held a year ago, when the principle of giving a high velocity of air by drawing it up into a rarefied chamber on the top of the inverted cone, and placing the jet at the point where the velocity was the greatest, seemed to be a sound one. At the same time, it was found that the drawbacks of inertia could be partly obviated by spraying the petrol through an annular nozzle around the cone, so that for some time one of the most popular types of carburetters was that in which the petrol was sprayed up around an inverted cone, the velocity of the air caused by the depression above the cone ensuring a more thorough mixture of air and spirit. The latest carburetter on this principle is the Decauville. An elongated cone has a stem passing through it, and is placed, apex downwards, in a conical mixing chamber, so that the stem rests on the bottom of a circular air inlet, surrounded by gauze, just below the apex of the cone. There is an annular space between the cone and the walls of the mixing chamber, which space may be varied by raising or lowering the cone with the aid of the stem projecting through the top of the apparatus. The cone is striated horizontally to facilitate the pulverisation of the liquid. When the cone is down on the cup forming the air inlet the petrol supply is also closed. The petrol is sprayed up from an annular nozzle around the cone just above the air inlet, and the annular spaces for petrol and air are, of course, proportionate. As the cone rises the "depression" at the top causes the air to rush up with the greatest velocity, drawing with it the required proportion of spirit. The advantages of carburetters of this type are a high-air velocity, a thorough mixing of the gas, and a low internal resistance whereby the engine gets the fullest possible charge. The principle of the cone is applied in a different manner by Grouvelle et Arquembourg, who base their carburetter upon experiments carried out with a horizontal tubular mixing chamber formed of conjugated cones, or, in other words, two truncated cones are jointed together at their smallest diameters. On the air passing through the chamber it is compressed into the smallest diameter, and expands again at the opposite end, where



HOZIER AUTOMATIC CARBURETTER

* No. II. appeared December 23rd, 1904.

the "depression" gives a high velocity through the narrow passage. The makers have calculated the dimensions to ensure a maximum velocity at a given point at all speeds, and it is at this point that the petrol jet is placed.

As all these applications of the cone principle involve patents, the majority of makers content themselves with perfecting the system of the supplementary air inlet. Even firms who have adopted alleged automatic devices are returning to what has become the ordinary type, with the additional air ports opened more or less by a piston actuated by the governor. Many refinements have been carried out in this system of carburetter, especially in the way of providing for the inertia of the petrol at low speeds. Nevertheless, from this point of view quite a number of the carburetters exhibited at the Paris show were practically worthless. The system of employing a large and small jet in one carburetter has proved very successful on the Léon Bollée cars, and it is now being applied, with some modifications, to the C.G.V. vehicles. In this double apparatus the engine runs with the smaller jet at low speeds, and is turned on to the bigger jet when the larger admission of air necessitates more petrol, so that the factor of inertia is a less serious one in obtaining a constant mixture. There are so many different types of carburetters in use that it would be hopeless to attempt to describe the special features of each. Some of these special features aim at overcoming certain drawbacks that ought not to exist in a perfect carburetter; such an one is the bulging out of the induction pipes in the Delaunay-Belleville engine, where any globules of petrol in suspension are retained in the ball-shaped enlargements of the pipes, and are drawn off by drip taps. The object of the annular spray nozzle in most of the improved types of carburetters is to break up the liquid in a very fine spray, and thus prevent the passage of globules which burn up instead of exploding in the cylinder. A carburetter of an entirely novel type, however, is the device which was shown for the first time on the Argyll cars of the Hozier Engineering Company, of Glasgow. As will be seen from the accompanying section of a carburetter for a two-cylinder engine, the float chamber is separated from the mixing chamber by a plate 4, in which are screwed two pump barrels 13. In these barrels are the plungers 14, which are raised and lowered by the disc 18. At each end of the plunger are ball valves, the upper valve chamber being formed by a cap, with three jets, having a capacity proportionate to the cylinder capacity of the engine. On the induction stroke the disc 18 is raised, and draws up the pump plunger with the required quantity of petrol, which is sprayed through the cap and mixes with the warm air entering by the ports 19. The travel of the pump can be regulated for fuels of different densities by means of the cams 21 on the spindle 22. The engine is governed by the two disc valves 31 in the induction pipes. The valve is kept off its seat by the spring 33. When the engine is running at its normal speed there is not sufficient resistance to overcome the tension of the spring, and the valve remains open; but as the speed increases, the "depression," or partial vacuum, tends to close the valve and diminish the supply of gas until the valve is on its seat, when the supply is cut off altogether. The engine can be controlled by hand by means of the lever 37 fixed to a collar on the valve spindle and passing through an oblique slot. The collar gives a variable pressure on the spring between the limits provided by the slot, and thus the valve is kept off its seat more or less according to the speed at which the engine is required to run. This combined carburetter and governor undoubtedly possesses great advantages, not the least being its extreme sensitiveness.

In paraffin carburetters there are many new and interesting devices, most of them having an auxiliary mixing chamber for starting the motor with petrol. The Claudel carburetter has given good results, and is largely employed upon paraffin marine engines, and this, as well as one or two others, is based upon the decomposition of the paraffin vapour, whereby the carbon is converted into oxide of carbon, which will burn without leaving a deposit. The paraffin carburetter is, in fact, a gas producer, in which the necessary chemical changes take place, without which it is found impossible to obtain an absolute combustion of the gas. As a rule, these carburetters are somewhat complicated, but a very simple apparatus exhibited at the Paris show is composed of a cylindrical chamber in which a long hollow piston, with slots of special form, slides over the vaporiser. Up through the centre of the vaporiser is a channel in which slides a stem of square section, tapering towards the bottom and carried on the piston head. The paraffin supply pipe opens into this channel, and the quantity of oil admitted is varied by raising or depressing the piston, and consequently the stem, in the vertical channel, whereby the supply is regulated at will. The paraffin descends into the vaporiser and mixes with air, passing through the slots in the hollow piston, which are calculated to give a supply proportionate to the quantity of paraffin. The Constantini paraffin carburetter is another new apparatus which seems efficient, to judge from its running in the annexe, and the same inventor was also exhibiting a vaporiser for heavy oils, especially in view of the employment of these fuels on motor boats, but little information could be obtained about the internal construction of these devices. Still another Constantini invention is an apparatus for injecting steam into the petrol charge. Many experiments have been carried out with the injection of steam or water, but while regarded as encouraging, they have not been followed by any practical result. This summary of carburetter practice shows that while there are endless variations of well-known principles in the designing of petrol carburetters, a good deal of progress has been made in paraffin vaporisers, which are likely to greatly facilitate the use of heavy oils in the early future.

In the construction of frames the most striking feature of the past year has been the almost universal adoption of pressed steel. This, of course, is what had been foreseen. Two or three firms still adhere to the flitch plate and wood frame, although it was observable on the chassis at the show that there was usually more plate than wood. The prevailing tendency to use steel is the outcome, partly, of the great length of the frames, and more especially of the facilities offered by the big metallurgical concerns like the Forges de Douai, St.-Chamond, and Firminy, who are making a speciality of steel frames. The U-section frame has not given such good results as had been expected, owing to its want of rigidity, and a great deal of trouble has been caused by the way in which the shocks on heavy cars were transmitted to the mechanism. With the increasing motive power and the fitting of heavier bodies, the makers of pressed steel frames had to introduce new designs. On medium-powered cars the frame more nearly approaches the channel section than the old deep U pattern, and it is invariably braced by cross members, and sometimes with angle pieces, while in the Richard-Brasier cars the pressed steel frame is strengthened by a tubular secondary frame, forming a bed for the engine and gear-box, with diagonal struts to the main frame. This is evidently intended to take off diagonal strains due to frame torsion. In the heavier cars it is now customary to press the frame out of one plate, which forms an "apron," or undershield. Many of these frames are wonderful examples of ingenuity in the art of pressing steel. They nevertheless give a heavy appearance to the chassis, and there is no reason to believe that this appearance is deceptive, for many of the big chassis are undoubtedly very heavy. Although there can be no question as to the rigidity of these frames, it may probably be argued that the system is being carried too far. It may be true that the makers have no alternative when they have to provide for such huge bodies as are now fitted to cars, and as the total dead weight increases, engines of greater power have to be fitted, with the result that the industry is tending towards unduly heavy, powerful, and costly vehicles. It is clear that a reaction will set in at no distant date. On medium cars the present types of frames, sufficiently braced, are satisfactory enough, and any weight cutting would be undesirable. Most builders now turn out cars with three sizes of frames—the long frame of about 8ft. 6in., generally with the under-shield, the medium frame of pressed steel braced with transverse members, and the short frame, this last being sometimes of the flitch plate and wood variety. Even on the light cars pressed steel frames are often used. This method of construction was seen in the small cars of Messrs. Gregoire and Cie., of Poissy, who were among the very few firms exhibiting light vehicles at the Paris show. To judge by the exhibits it might be supposed, indeed, that the French makers were entirely neglecting the low-priced light car. The Gregoire vehicle is modelled on the lines of the big car, and is of excellent construction throughout. Fitted with a motor developing 7½ horse-power, the total weight of the vehicle in full running order is not more than 500 kilos., which is an excellent result for a car of this type. Another interesting feature in frame design is the tendency to make the frame to suit the carriage bodies, instead of obliging the coachbuilders to do the best they can with straight frames. The Société d'Industrie Mécanique showed a frame curved to take a brougham body, and among the Arbel frames were several curved more or less according to the forms of the bodies to be fitted to them. In the suspension of frames many improvements have been carried out. On big cars the back springs are invariably placed outside the frame, and Mors and some other firms are adopting the transversal back spring supporting the ends of the side springs, thus giving a three-point suspension. While suitable for good roads, this method tends to an excessive swinging of the body when travelling at high speeds over indifferent roads. The usual practice is to fit long springs, the rear ends being supported by brackets projecting behind the frame, or else hinging on the ends of inverted half springs fastened to the side members. There are many variations in the method of suspension, and this part of the car construction represents a decided improvement.

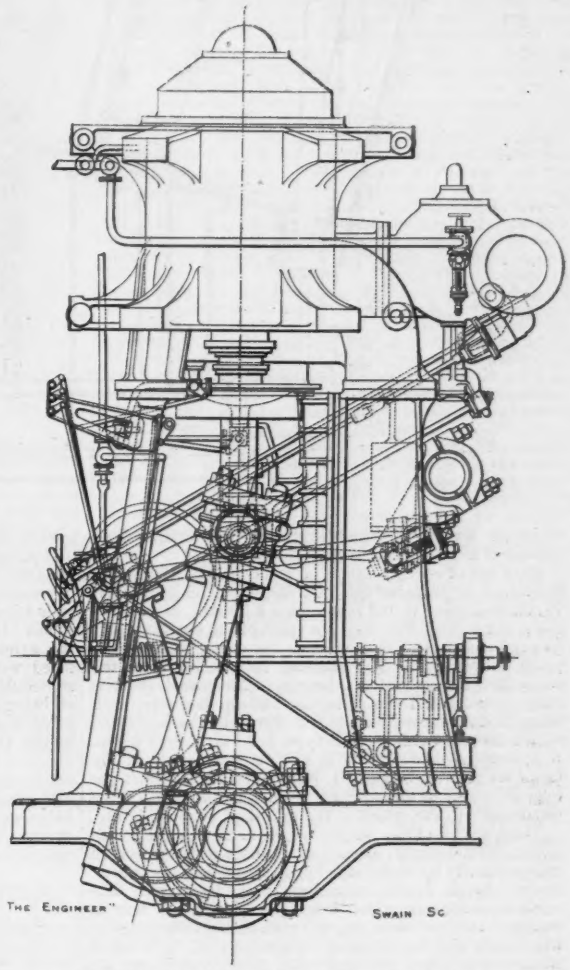
THE JUNIOR INSTITUTION OF ENGINEERS.—On the invitation of the chairman, Mr. Samuel Cutler, jun., M.I. Mech. E., a large number of the members of this Institution recently visited the International Gas Exhibition at Earl's Court. They were received by Mr. J. W. Helps, M. Inst. C.E., chairman of the Advisory Committee of the Institution of Gas Engineers, under the auspices of which the Exhibition was held, and shown over by him and Mr. S. Y. Shoubridge, of the South Suburban Gas Company; Mr. A. E. Broadberry, of Tottenham; and Mr. A. W. Onslow, of the Royal Arsenal, Woolwich.

THE LEEDS UNIVERSITY ENGINEERING SOCIETY.—Mr. J. H. Walker, an old engineering student of the University, delivered an interesting lecture on "The New High-level Bridge at Newcastle." Having shown the necessity for increased facilities for trains travelling north and south, Mr. Walker proceeded to give particulars of the construction of the bridge. It consists of four main spans, of five girders each, resting on three piers in the river, and the necessary arches at each approach. The lowest point will be 80ft above high-water level. The piers rest on caissons, sunk, by means of compressed air, down to the solid rock. The building and sinking of these caissons were fully described by the aid of lantern slides and a working model. Grave difficulties were encountered when digging foundations for the arches, owing to old coal workings, incurring an additional cost of £12,000. With a small exception, all power used by the contractors, the Cleveland Bridge and Engineering Company, is derived from electric motors.

ENGINES OF H.M.S. BLACK PRINCE.

THE propelling engines of the Black Prince, a plan and elevation of one set of which we give in our double-page Supplement, and in end elevation below, are collectively of 28,000 I.H.P., and are being constructed at the Thames Ironworks and Shipbuilding Company's engineering works at Greenwich and Deptford—formerly Messrs. John Penn and Sons. There are two independent sets—in separate engine-rooms—of inverted-cylinder twin-screw engines designed to give the ship a speed of twenty-three knots an hour. Each set is of the four-cylinder four-cranked triple-expansion type, the sequence or arrangement of the cylinders, reckoning from forward, being low, high, intermediate, and low, and their diameters in that order 77in., 48½in., 69in., and 77in., all having a piston stroke of 3ft. 6in. All the cylinders, which are made of tough cast iron, are steam jacketed, the working barrels or liners of the high and intermediate-pressure cylinders being of forged steel, and those of the low-pressure, close grained cast iron.

The pistons are of cast steel, of hollow conical shape, the piston-rods being of forged steel, 10in. diameter for the high and intermediate, and 8in. for the low-pressure pistons; all the rods are packed with metallic packing. The steam distribution valves to the high and intermediate-pressure cylinders are of the piston type, those to the latter being duplex; while treble-ported flat valves are fitted to the low-pressure cylinders, with balanced relief



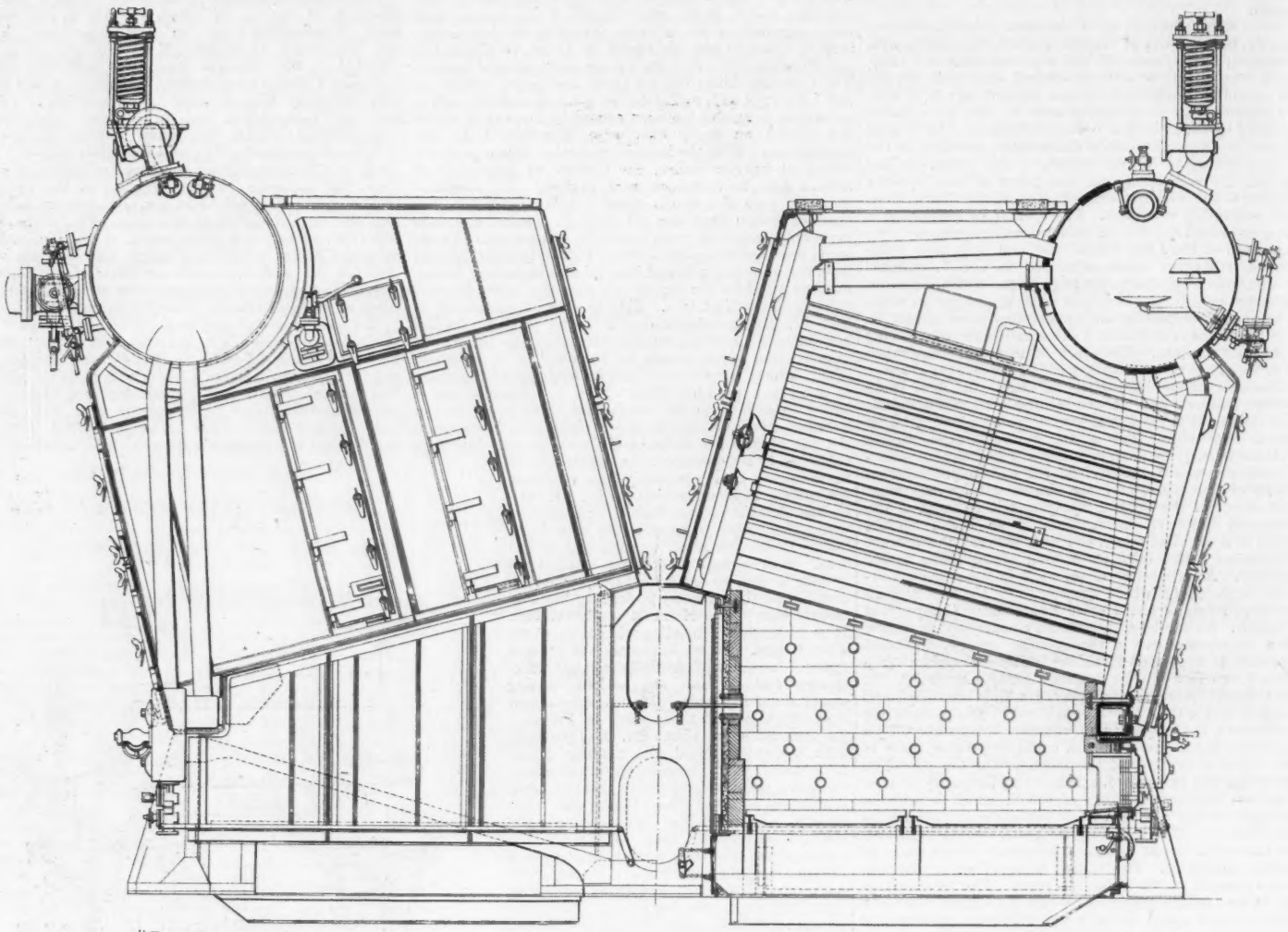
ENGINES OF H.M.P. BLACK PRINCE—END VIEW

rings at their backs. All the valves are actuated by ordinary double excentrics and twin bar links, the reversing levers being provided with screw gear, that each valve may be linked up independently.

Each cylinder is supported on two wrought steel columns in front, and a cast iron column at the back, to which the piston-rod guides are bolted; the cylinders are stayed to each other by the usual ramming stays, with allowance made for their expansion when hot. The bed-plates are of cast steel of channel form, connected by distance pieces, and firmly bolted to the engine seatings worked up from the ship's frames.

The engine crank shafts, which are fine specimens of steel forgings, run in gun-metal bearings lined with white metal; the shafts are made in four separate parts, and interchangeable; the diameter at the bearings are 18½in., and at the crank pins 20¾in., the former having a 9½in., and the latter a 11¾in. diameter hole through them. The aggregate length of the shaft bearings is 15ft., to the lubrication of which special attention has been given. The connecting-rods are also of forged steel, and have adjustable bearings at each end. They are 7ft. between centres. The balancing of the engines is in accordance with the Yarrow, Schlick, and Tweedy system, whereby the inertia of the moving parts is neutralised and very steady running ensured. Each set of engines is fitted with both steam and hand reversing gear, the reversing engine being so arranged that it may turn the main engine shaft by means of clutch gear and a chain wheel specially provided for the purpose; the turning wheel

H.M. CRUISER BLACK PRINCE—BABCOCK AND WILCOX BOILERS



is keyed on at the mid-length of the crank shaft instead of at the end as usual.

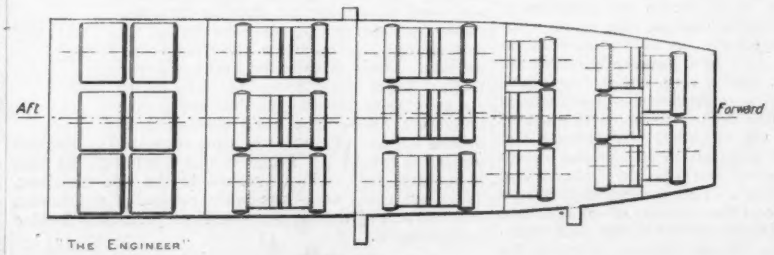
Each set of engines drives a three-bladed manganese bronze screw propeller 16ft. 6in. diameter, and is arranged to run at a speed of 133 revolutions a minute, its rotation being outwards. The distance apart of the shafts at their forward ends is 16ft. 6in., and at the centre of the propeller bosses 22ft. The shafting is parallel with the water-line throughout its length. The thrust shaft is 18in. diameter and the stern shaft 23½in. diameter, each being hollow throughout. The thrust blocks are fitted with collars of the horseshoe type, lined with white metal. A feature of this shafting is the unusual length of the propeller shaft, it being 85ft. 7½in. long in one piece; the over-all length of the shafting, from the after end of the crank shaft to the centre of the propeller, is about 114ft.

There are two twin air pumps, 31in. in diameter, with a 16in. bucket stroke, to each set of main engines, worked independently by their own engines, and delivering their water through grease extractors to the feed tank. The surface condensers, which are of cast brass, are four in number, two to each engine-room, fixed in the wings of the vessel, with one common exhaust pipe to each set of main engines, and provided with sluice valves on the exhaust air and circulating pump water branches, so that any condenser may be shut off for repair or cleaning while the others are at work. The cooling water for the surface condensers, the combined cooling surface in which is 28,000 square feet, is delivered to them by two centrifugal pumps in each engine-room, capable of delivering 1400 tons of water from the bilges per hour, with a steam pressure of 125 lb. per square inch, at 300 revolutions per minute. There are two fire and bilge pumps fitted in each engine-room, each capable of discharging 120 tons of water per hour.

In each engine-room two evaporators and one distilling condenser are fitted, which provide a total of 240 tons of fresh water per twenty-four hours, for making up the loss of steam by leakage or otherwise in the main and auxiliary machinery, and for furnishing an ample supply of drinking water. Provision is made for increasing the steam pressure in the auxiliary exhaust pipes to about 25 lb. per square inch, so that the exhaust steam from the auxiliary machinery may be discharged into the main low-pressure cylinder receiver, or may be used for the evaporators.

Steam for the propelling engines of the Black Prince will be supplied by twenty water-tube boilers of the Babcock and Wilcox type, each of which can be worked independently; and six cylindrical boilers, all to be worked at a pressure of 210 lb. per square inch, their relative positions in the ship being shown in the plan, and the construction of the water-tube type in section and elevation on this page. The total heating surface in the water-tube boilers is 51,040 square feet, and the grate surface 1421 square feet. The cylindrical boilers are three-furnaced, and are each 13ft. 6in. diameter, and 9ft. 6in. long, and have a total heating surface of 11,250 square feet, with 360 square feet of grate area, the water-tube boilers being worked with natural, and the cylindrical with forced draught.

The boilers are contained in four compartments, the cylindrical boilers being in the after one, which is fitted with the usual air locks. Air is supplied to the stokeholds by eighteen Sirocco fans, each 35in. diameter, all being electrically driven. Each boiler compartment is fitted with a main and auxiliary Weir feed engine; those in the forward compartments having 12½in. and 17½in. diameter cylinders, with 24in. piston strokes; in the two middle compartments, 11½in. and 16½in. cylinders, with 24in. stroke, and in the cylindrical boiler-room, 11in. and 15¾in. cylinders, with 21in. piston stroke. The main-feed engines supply any or all of the boilers in their own compartments; the auxiliary-feed engines are connected



PLAN OF BOILER-ROOMS

up to a common range, thus being able to supply any boiler throughout the ship.

While a considerable part of the auxiliary machinery fitted in the Black Prince will be of the Thames Ironworks Company's own manufacture, some special machines, included in her outfit, are necessarily the production of outside specialists, each of whom is responsible for the efficiency of the thing supplied. As they mostly embody in their design the very latest improvements, their capabilities may here be briefly noticed. The machines comprise those for electric generation and air compression, by Mr. Peter Brotherhood; evaporating and distilling, by Messrs. Caird and Rayner; steering, by Messrs. Bow and McLachlan; and fan machinery, by Messrs. Davidson and Co.; all of which have, we believe, been made interchangeable with all the cruisers of the Black Prince class, built and building.

The electric generating machinery consists of four 105-kilowatt six-pole dynamos, by Laurence Scott and Co., each coupled to a Brotherhood enclosed engine of 175 indicated horse-power, the generating sets being the largest and most powerful which have been supplied for the Navy. The engines for driving the dynamos—which run at 400 revolutions per minute—are of a specially light and compact design, carefully balanced, and provided with sensitive governors, to ensure the satisfactory running of the generators in parallel under large fluctuations in load, the speed variation being only 1 per cent., and momentary increase less than 5 per cent. when the load is suddenly removed, thus making it possible to operate large intermittently-running motors, taking heavy starting currents, without affecting the incandescent lighting.

The air compressors for torpedo service are electrically driven, and are of the four-stage type, provided with intercoolers to reduce the temperature between each stage of compression, the air pressure being 2500 lb. per square inch. They are driven at 350 revolutions per minute by six-pole 40 horse-power motors, directly coupled. The compressors are provided with regulators for varying the output of compressed air without any alteration in the speed of the motor, thus allowing shunt motors to be used with the simplest type of starting switch.

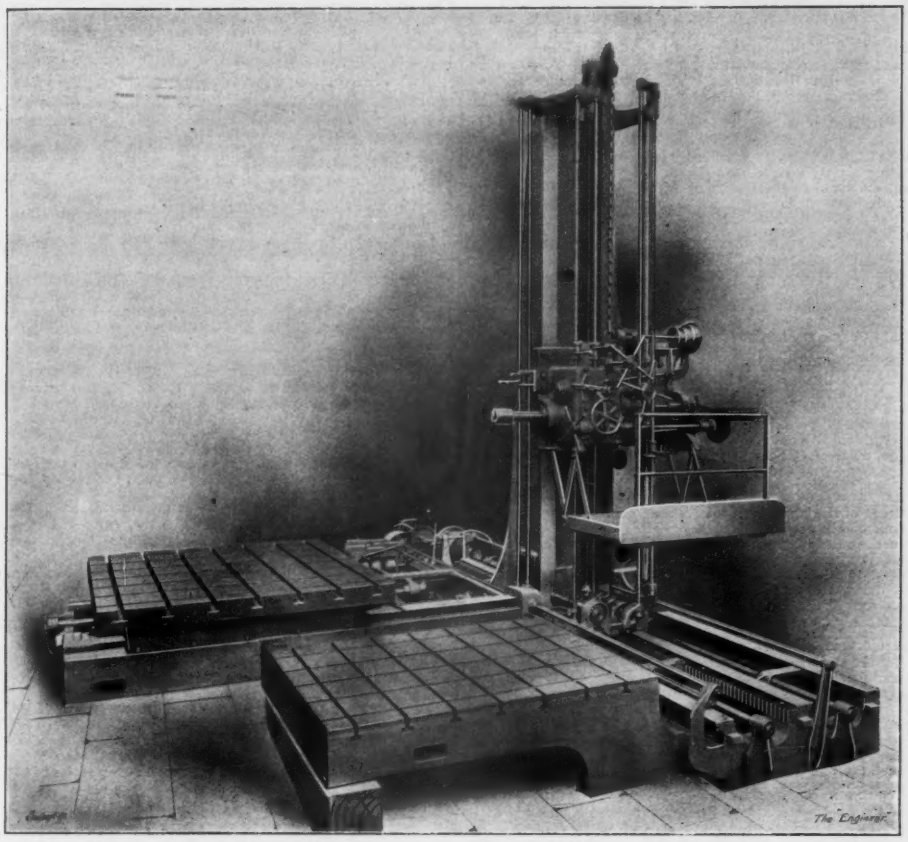
The evaporators fitted will, when worked with steam at 25 lb. pressure, evaporate from sea water a total of ten tons an hour; and the distilling condensers are capable of condensing all the steam from the evaporators, into water at a temperature not exceeding 150 deg. Fah.; and of providing 2½ tons an hour of cool drinking water.

The steering engines, which are of the independent double-cylinder type, are designed for the full boiler pressure of 210 lb.; but each is powerful enough to turn the rudder from hard over to hard over in 30 seconds; with the steam at 175 lb. per square inch, the vessel going at a top speed of 22 knots, the resistance to be overcome at this speed being 320-foot tons. These engines may be controlled from either the bridge, the conning tower, or the lower deck fighting position. They may also be manipulated at the engines themselves, indicators and dials being provided for the purpose.

The fans—of "Sirocco" make—supplied for forced draught purposes have an average speed of 440 revolutions, at which the output of air per minute is 23,400 cubic feet, while maintaining an air pressure in the stokehold equal to 1in. of water, and requiring on test but 9 brake horse-power to obtain it.

HORIZONTAL DRILLING, MILLING, AND BORING MACHINE

MESSRS. WARD, HAGGAS, AND SMITH, KEIGHLEY, ENGINEERS



Although the order for the building of the Black Prince was placed with the Thames Ironworks Company early in the year 1903, owing to the propelling machinery of the vessel and that of her sister ship the Duke of Edinburgh—then building by Messrs. Hawthorn, Leslie and Co.—having to be made interchangeable, some considerable time was spent in deciding upon the arrangement and details for the two vessels, so as to bring them into line, so that it was not until early in June, 1903, that all material for the boilers and heavy working parts of the engines, had been ordered. By the following September the heavy castings and forgings were beginning to be delivered; three months later six of the main engine cylinders were cast, and machining on them and other parts was fairly under way. By March, 1904, the work on the main engines was so far in hand that a start was ready to be made in the erecting shops, and in June all parts of the engines were so well advanced that it was then expected that both sets would be finished in good time for the ship when ready to receive them. This interchangeability of the parts of machinery has involved an immense amount of labour in the making of templates, gauges, and jigs, the greater part of which have been produced at the engineering works of the Thames Ironworks Company, at Greenwich, where special shops have been set apart for their construction and storage.

A general description of the Black Prince was given in our issue of November 11th last.

HORIZONTAL DRILLING AND MILLING MACHINE.

THIS machine, illustrated above, consists of a bed having three faces, upon which slides an upright carrying a spindle carriage. The upright, which is of box section, is guided by the front and middle surfaces of the bed, and is provided with a large strut cast out at the back which rests upon the outer surface of the bed, and thereby provides a wide base to take the pressure of the drill. It has quick power or hand adjustment, as well as milling traverse in either direction along the bed, controlled by levers on the drill head. The power for traversing is transmitted by means of friction clutches, these being used to obviate the shock to gearing when starting or reversing the traverse. The friction clutches drive through worm wheel and pinion gearing into a rack running the whole length of the bed.

The drill head is balanced by a weight sliding down the back of the upright. It is also provided with quick hand or power adjustment, as well as milling traverse in either direction by means of friction clutches and worm wheel and screw in the upright, controlled by a lever in a convenient position. The spindle is of steel, sliding in a long cast iron socket, which runs in conical bearing with check nuts to take up the wear. The spindle is made long enough to extend through the feed rack—which is made larger in diameter for this purpose—and is lined with brass at each end to give extra bearing, in addition to the ordinary bearing in the socket. The spindle has a variable self-acting feed motion by means of a three-speed cone, as well as quick and slow hand adjustments, and is also provided with reversing motion, and change of speed for tapping. A platform is attached to the upright, upon which the operator stands, all the handles and levers, by which all the motions of the machine are controlled, being grouped on the drill head within easy reach.

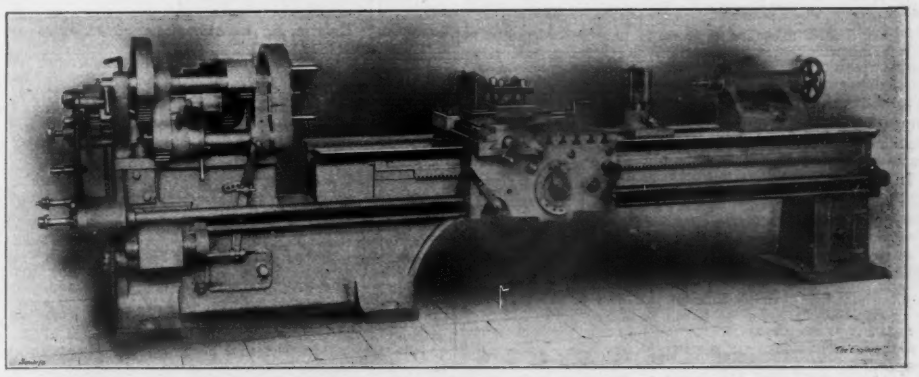
In front of the main bed, and at right angles to it, another bed is bolted. This second bed has planed and scraped faces, upon which slides a large square block carrying a square revolving table, which is provided with T slots for holding the work, and having a plunger pin for setting it at 90 deg. This table is revolved by means of a large spur wheel firmly bolted on the underside, with which meshes a pinion driven by a worm and worm wheel. The motive power for this, as well as the adjustment to and from the spindle, is derived from pulleys and reversing friction clutches at the end of the main bed, and operated by levers on the drill head. Another stationary table is also bolted to the main bed, so that while one article is being machined another may be got ready, and thus the machine need not stand idle.

The machine is driven by a five-strap cone pulley, taking a 4½in. belt driver, either direct or through suitable double purchase gear, a horizontal shaft running the full length of the main bed—provided with sliding bearings at suitable intervals—and gearing with a vertical shaft which drives the spindle.

The machine has been designed by Messrs. Ward, Haggas and Smith, of Keighley, for the use of high-speed drills, and all the gear is of steel, machine cut from solid blanks. The finished weight is about 39 tons.

TREBLE-GEARED HIGH-SPEED LATHE.

THE lathe illustrated below has been designed specially for the economical use of high-speed tool steels. It is provided with a four-step belt cone, which drives the spindle through single, double, or treble gearing. The cone diameters are 11⅜in., 9⅜in., 7⅜in., and 5⅜in., and the steps are 2⅜in. wide; the greatest gear ratio is 27 to 1. The saddle has self-acting, surfacing, and sliding motions operated from a front shaft, and controlled from the apron. The leading screw is provided with a double clamp gun-metal nut. The feed motion is chain driven, and permits of three changes without stopping the lathe. The loose head has a cross slide for taper work. The gear throughout, including change wheels, is cut from the solid. The principal dimensions are as follows:—Centres, 9in.; dimensions of bed, 12ft. by 15in. by 11¾in. deep; diameter and length of spindle bearings, front 3in. by 4½in., and back 2in. by 4in.; leading screw, 2in. diameter; gap, 9in. by 17¼in. The countershaft pulley is 15in. diameter, and is intended to run at 360 revolutions per minute. The total weight of the lathe is 45 cwt. It is made by G. Wilkinson and Sons, Bradford-road Tool Works, Keighley.



9-INCH HIGH-SPEED LATHE

WHEEL GEARING.

AT a recent meeting of the Birmingham Association of Mechanical Engineers a paper on "Wheel Gearing" was read by Mr. W. H. Thornbery, M.I. Mech. E. At the commencement of the paper the author makes a few remarks on "Main Gearing," pointing out that the earliest method of distributing power was the use of spur gearing on the main engine shaft, and more recently by Fairbairns' method of constructing the flywheel in the form of a spur wheel, which transmitted the power to a pinion on the second motion shaft, and then through mitre wheels to a vertical shaft, from which a main line shaft on each floor of the factory was driven also by mitre wheels. Driving by belts and ropes has now largely taken the place of toothed gearing, and is, perhaps, in most cases more suitable; but the author states that in the Lancashire district at the present time rope driving is not so much in use as formerly, steel toothed wheels having superseded it in many cases, and he considers that where regularity and exactitude of motion are necessary, then toothed gearing must be used, except where the modification of chain driving is employed. On the question of "Shape of Teeth of Wheels" the author has not much to say; he gives a brief account of the different types of teeth—the cycloidal and involute—and points out that the latter have the advantages that if the distance between the centres of the axles is altered by wear of journals or otherwise, the teeth still act directly so long as they will drive at all, and that any two involute wheels of the same pitch will gear correctly together. On the other hand, there is more obliquity of action than in the other forms. The length of the tooth is another important question which is discussed, but it is obvious that this must be made as small as possible to secure strength after one condition has been fulfilled, and this is there must always be sufficient teeth in gear to give continuous motion. The distance between the shafts with cycloid teeth must be absolutely constant, otherwise there will be very inefficient driving. With reference to a statement which is often made in connection with this class of teeth, which is, that if the teeth of wheels are properly formed they roll on each other instead of sliding, the author states that this theory is not accurate. "The contact is a sliding one, except at the exact instant when the meeting surfaces of the teeth cross the line of centres—that is, the line joining the centres of the shafts, which are geared together. At that infinitesimally small portion of time the driving tooth simply pushes the driven." The friction between the teeth will be greater before their surfaces reach the centre line than after doing so. It is, therefore, necessary to so design them that all—or as much as possible—of the friction shall take place after passing the centre line. It is stated that this is done when the driving wheel has its teeth formed only as "points"—that is, the portion external to the pitch line—and the driven wheel has its teeth only "flanks"—that is, parts internal to the pitch line. These teeth work very well, but have the disadvantage that they will only drive correctly in one direction. The breadth of the tooth in ordinary mill gearing is fixed at from twice to four times the pitch. The broad tooth has the load evenly distributed over it, especially in machine-cut wheels, and the wear is thus diminished. But in cast spur wheels it is not practicable to make the faces too broad, as it increases the chances of inaccurate workmanship, and the wear then would be very uneven. There are a few interesting remarks made on helical gearing, which shows that this class promotes steadiness and uniformity of running, but the great objection to its use lies in the difficulty of manufacture. Another drawback seems to be that there is an "end-long" thrust on the shaft, but to overcome this difficulty a combination of right and left-hand helices, known as the double helical toothed wheels, are made, and are successful. To give some idea as to the size of spur wheels made at the present time, the teeth of which are machine cut, it is stated that a firm in the United States makes cut gears up to 30ft. diam. and 66in. face. Also Messrs. Scott and Hodgson, Guide Bridge, near Manchester, cut wheels up to 26ft. in diameter. The following list is given for the greatest speed at which the various wheels may be safely run; the speed is taken at the pitch circle, in feet per minute:—Ordinary cast iron wheels, 1800; helical wheels, 2400; mortice wheels, 2400; machine-moulded cast iron wheels, 2000; machine-moulded steel wheels, 2500; machine-cut wheels, 3000. These speeds are occasionally exceeded, but the author thinks that the speeds given are sufficiently high for all practical purposes. He mentions the case given by Professor Unwin, in which the speed reached 5760ft. per minute, but at this the wheel broke, apparently from centrifugal force.

RAILWAY MATTERS.

IT is exactly thirty years since the Midland Railway Company abolished second-class carriages on its system.

ENDING with November 14th—new style—433 miles of new railways have been thrown open to traffic in the Russian Empire during the present year.

EIGHTY-FIVE and six-tenths per cent. of the freight cars of the United States now have air brakes, according to the last report of the American Railway Association.

THE prize of M. 6000, offered by the German Society of Mechanical Engineers for the best scientific treatise on locomotives, has been awarded to Professor von Borries, who has been assisted in the work by Professor Sommerfeld, of Aix-la-Chapelle, and Herr Berner, of Berlin.

THE feeling of tension between the Hindu and Mahomedan employés of the North-Western Railway in India seems to be on the increase, because the former is strong at the helm, and, it is alleged, uses that strength to the disadvantage of the latter in many ways.

THE Sheffield Corporation Tramway Department during 1904, so far as the figures are available, carried passengers exceeding the number carried during 1903 by over a million. Up to the 4th inst. 62,579,886 passengers were carried, and the car miles run were 5,658,926. There are nowover 64 miles of single track—excluding depôts—and the total number of employés is 1386.

A NOTEWORTHY long-distance non-stop run was modestly announced by the London and North-Western Railway in connection with the Holyhead route to Ireland for the Christmas holidays. The journey between Euston and Holyhead mail pier by a special train leaving Euston at 8.43 p.m. was announced to be accomplished without intermediate stops. The distance is about 264 miles.

A NEW automatic buffer coupling, which is the invention of Mr. S. J. Coles, was on exhibition at the London and North-Western Railway offices at Euston last week, when the invention was explained to a number of railway engineers. The coupling was shown in working order, attached to two model wagons. The patent not only couples the vehicles, but at the same time connects the Westinghouse or vacuum brakes.

THE promoters of the authorised Clay Cross Railway have deposited a Bill for introduction into Parliament next session, for leave to abandon the construction of their line, and to wind up and dissolve the company. The Clay Cross Railway Company was incorporated by Parliament in 1902, with power to construct a railway connecting the Clay Cross collieries and works with the Lancashire, Derbyshire, and East Coast Railway, near Chesterfield.

IN an article on railway collisions in America, the *Railroad Gazette* states that the time is surely coming, and should not be far distant, when a definite measure to make block signalling compulsory on lines subject to certain traffic conditions will be brought before Congress. In spite of the grave and patent objections to governmental interference with railroad operation, the collision evil must be squarely met, and the only way of accomplishing this seems to be to extend the Safety Appliance Act of 1893 to include the block system.

MR. JOHN ELLIOTT, chief outdoor assistant in the traffic department, Midland Railway, has been promoted to superintendent of the line, in place of Mr. T. Eaton, resigned, and he will take up his new work on January 1st. Mr. Elliott for a considerable time was in charge of the Midland Company's terminus at St. Pancras. When the scheme of decentralisation in the traffic department was put into operation, Mr. Elliott became district superintendent for London, and two years ago he was appointed chief assistant to Mr. Eaton, at Derby.

A FAVOURABLE report has been issued on the possibility of piercing the Alps, by a railway connecting the Bernese Oberland and the Simplon, without, as do the present day trains from Berne to the Rhone Valley, running westward to touch lines bordering the Lake of Geneva. It would connect Berne with Brigue in the Rhone Valley—the Swiss terminus of the tunnel—by a total route of 72½ miles, running south through the Blumenstein and Wildstrübel mountains to the Rhone, and then turning east through the canton of Valais to Brigue. The greatest elevation reached would be 1128 m. The region supplies abundant water-power for electrical working.

AMONGST the official awards made to the Pennsylvania Railroad System by the juries of the St. Louis Exhibition the chief is a special commemorative gold medal for its original series of scientific investigations of locomotive performance conducted at the Louisiana Purchase Exposition, the methods and results of which are a permanent contribution to the advancement of engineering knowledge. The committee of five, composing the superior jury, "was unanimous in this action, and each member individually expressed his high appreciation of the magnificent work done by the Pennsylvania Railroad System in establishing and conducting this testing plant."

A RAILWAY museum may be formed as a result of the St. Louis Exhibition, the large historical locomotive collection of the Baltimore and Ohio Railway and other exhibits forming the nucleus. The historical collection referred to was exhibited at the Columbian Exhibition at Chicago in 1893, and afterwards presented to the Field Columbian Museum at Chicago, which was established as an outcome of the Exhibition. This institution, however, has practically decided to confine its scope to pure science, and the applied science section may be abolished. The disposal of the Baltimore and Ohio Railway collection is at present uncertain, but the establishment of a railway museum at Philadelphia has been proposed, and a large building has been offered for the purpose.

FURTHER plans of railway extension, with a view ultimately to the completion of a trans-continental system, are disclosed by a couple of applications to the Canadian Government for charters of which Messrs. Mackenzie and Mann, of Toronto, have given notice. One of these applications is leave to build a line from Byng Inlet, at the mouth of the French river on Georgian Bay, to Montreal, *vid* Ottawa. The second is for the right to construct a railway from a point on the Jane Bay line north of Toronto to Montreal, *vid* the capital. At Montreal, Messrs. Mackenzie and Mann's system, the Canadian Northern Railway, will be in touch with the inter-colonial, and consequently will get an outlet to the east in winter time. In order to bring their western system into touch with their eastern lines, it will be necessary to build from Port Arthur to Sudbury.

TAKING into consideration the peculiarly aggressive tone of the Russian Press with regard to the mobilisation of the Russian forces in view of a campaign against Afghanistan or India, no little importance is to be attached to the decision arrived at by the Russian Government that it will purchase the Vladicaucas Railway before the beginning of 1906. There are 16,325 shares in this company, and while 7325 shares are held by private persons, the remaining 9000 shares are in the hands of the Russian Government. Prince Khilkoff, the Russian Minister of Ways of Communication, has summoned a meeting of the shareholders to be held in about ten days' time, and the question whether or not Russia shall become the sole owner of this highly important line of railway between South-East Russia and the Caucasus region, and Persia, will be settled at this meeting.

NOTES AND MEMORANDA.

THE total production of Portland cement in the United States in 1902 was upwards of 17,000,000 barrels, or 31·5 times greater than in 1892. The total consumption of domestic and imported Portland cement in 1902 was upwards of 19,000,000 barrels, or nearly 6·5 greater than in 1892.

CONCRETE has been used to a large extent for many years in the construction of reservoirs, but not until recently has concrete-steel been used for this purpose. The Louisville Water Company completed in 1900 a clear-water reservoir, 394ft. by 460ft. and about 25ft. high. The walls and columns were concrete, and the roof concrete-steel groined arches of about 19ft. clear span.

IN the course of a paper read before the Manchester Association of Engineers on the "Economic Value of Cast Iron," the author, Mr. W. H. Pretty, humorously described cast iron as consisting of iron, with the addition of small quantities of carbon, silicon, sulphur, phosphorus, and manganese; and "anything else it can lay its hands on;" the latter undefined components are not by any means the least important.

AN alternative design for the two armoured cruisers submitted by an American shipbuilding company in connection with its bids for the construction of new vessels contemplates turbine engines for the ships, but the United States Board of Construction will not recommend the adoption of the proposed plans. It is not deemed feasible for the Government to expend at this time £140,000 to try turbines in armoured cruisers.

THE first attempts to prepare aluminium, based on the electrolysis of alumina, were made in 1808 by Davy, but they did not meet with the success that physicist obtained on electrolysing the hydrates of the alkalies and alkaline earths. But if Davy did not produce pure aluminium, it is probable that he obtained in some of his experiments an alloy of aluminium and iron, for his cathode, made of a sheet of iron, appeared at the end of some experiments whiter and more brittle than previously.

THE rotary cement kiln was invented by Frederick Ransome, of England, in 1885, but has been perfected and made a commercial success in the United States. In 1893 rotary kilns were used in the manufacture of 25·2 per cent. of the Portland cement produced in the United States, and in 1900 this had increased to 81·5 per cent. The cement consumed in the United States during the year 1902, estimating one barrel of cement to 1 cubic yard of concrete, was sufficient to build a wall 1000 miles long, 20ft. high, and 7ft. thick.

AN electric resistance furnace was used by Pepys in 1815 for the cementation of iron. He took a piece of pure, soft iron and cut a slit along its length. The slit was filled with diamond dust, which was prevented from falling out by fine iron wire. The portion of the wire containing the dust was wrapped in mica. The wire, thus charged, was heated quickly to redness by the current from a battery. On opening the wire Pepys found that the diamond dust had disappeared, and that around where it had been the wire had been converted into steel.

FIVE piers on North Platte River, Wyoming, Union Pacific Railroad, were built at 30 deg. Fah. with hot concrete. In setting it was found that the south ends of the piers had moved west from ⅜in. to 1¼in., and had also settled from ¼in. to 3in. more than the north ends. Concrete piers for steel bridges are not usually reinforced with steel, but six concrete piers, reinforced with steel bars, are now under construction for a plate girder bridge over the Cuivre River, on the Chicago, Burlington, and Quincy Railroad, and old railroad rails have been used for pier reinforcements on other railroads.

ACCORDING to *Le Yacht*, work is proceeding on the three new submarines Emérande, Opale, and Rubis, designed by M. Maugas, who also designed Z. These boats will be the largest submarines yet constructed. The displacement will be 422 tons; length, 146·5ft.; beam, 12·8ft. They will have two propellers; the motive power will be gas or vapour on the surface, and electricity from accumulators when submerged; the engines will be 600 horse-power; and the speed, 12 knots. They will each carry six torpedo tubes. They will be more habitable than previous types, and have a larger radius of action.

WE understand that Mr. J. F. Brooks, who is in charge of the engineering laboratories at the Leicester Technical School, is carrying out research work upon the relations between the forces reacting upon the tool and cutting angle and the form of the turnings given off. A special tool rest has been constructed, enabling the forces to be obtained in three directions at right angles, representing the axis of co-ordinates, and, in conjunction with microphones, the exact loads are easily determined. A microscope and camera are attached to the tool rest, enabling permanent records of the cutting action to be made while the tool is actually at work.

A DECISION has been rendered by the United States Commissioner of Patents to the effect that an inventor who has completed the inventive act by reduction of his invention to practice may lose his right to obtain a patent, in favour of a subsequent inventor, by concealment and delay in applying for a patent, says the *American Machinist*. A person who refuses to instruct the workers in the art and seeks to protect himself in the use of the invention by keeping it secret, thus apparently leaving the field of invention vacant to stimulate the activity of other inventors, cannot secure a patent in the face of the claims of a later inventor who has given the invention to the public.

THE project to build large storage reservoirs in Connecticut on the upper waters of the Naugatuck River and the streams that make up the river is a philanthropic enterprise, with a purpose of removing the nuisance occasioned by the emptying of sewage in the river. The city of Waterbury is in trouble regarding its sewage, which is emptied into the river, rendering it offensive at times. Two years ago it was suggested by prominent men of the Naugatuck valley that storage reservoirs be created, so that sufficient water might be accumulated during flush times to clean out the river when it becomes low, thus enabling Waterbury and other towns and cities in the valley to continue to empty their sewage into the stream.

BUNSEN showed, by his researches upon the capillary of a glass receiver upon the gases enclosed might be greatly increased attraction of a glass surface upon gases, that the absorbing effect by the introduction of glass fibres or filaments into the bulb. M. Krouchkoll, in *Comptes Readus*, has applied this fact in the regulation of the vacuum in Crookes tubes. A little side tube fused into the bulb is stuffed with glass wool, and the vacuum may be reduced at once by applying heat to this tube. The regulation is, to some extent, automatic, as, when the anti-cathode becomes hot, the heat radiated in the bulb is sufficient to set free some of the gas occluded in the glass wool, thus keeping the tube constant, when in continuous action, for a long time.

A SCOTSMAN named Neilson, who has been resident for some time in Italy, is said to have discovered an obliging microbe, hitherto unknown, which devours all zymotic germs in sewage, and when it has completed its task dies and dissolves. Mr. Neilson is said to have invented an automatic biological tank, applicable to dwelling-houses of any description, wherein his microbe disports itself by transforming the sewage into odourless, colourless liquid which is perfectly innocuous to human life, and may therefore be safely permitted to flow off into street drains, and thence into rivers. This transformed liquid has been subjected to the public analyst by order of the Commune of Florence, and it is pronounced to be "clear water, but undrinkable."

MISCELLANEA.

APPLICATION is to be made by the Walsall Town Council for a loan of £5000 for land for sewage farm purposes.

FOR its exhibits in the St. Louis Exhibition, Ceylon has been awarded 19 grand prizes, 16 gold medals, 119 silver medals, and 72 bronze medals.

THE election is announced of Mr. Philip Watts, F.R.S., Director of Naval Construction, as a vice-president of the Junior Institution of Engineers.

HIS Royal Highness the Prince of Wales has consented to be vice-patron of the Automobile Club of Great Britain and Ireland, of which his Majesty the King is patron.

AN electric crane, to cost about £15,000, is being built by a Carlisle firm of engineers for shipment to South Africa. It will be the largest crane of its kind that has been built.

THE Tees Valley Water Board have decided to add £10,500 to the estimate for the Long Newton reservoir, £3150 to the estimate for the tunnel from Grassholme to Hury, and £1000 to the Hury reservoir.

THE correspondent of the *Times* at Rome states that, according to the *Patria*, negotiations have been entered upon by the Italian Minister of Posts and Telegraphs and the British Postmaster-General with a view to establishing wireless telegraphic communication between the stations of Poldhu and Bari.

IT is now feared that the new United States armoured cruiser squadron will not be ready for commission before next July. The squadron will consist of the armoured cruisers Maryland, West Virginia, Virginia, and Colorado. It will be attached to the North Atlantic fleet and will form the cruiser squadron of the fleet. It will be an independent squadron, and will exchange stations with the other squadrons of its class as soon as the vessels to constitute them have been completed.

IT appears that the excellent results obtained by the Motor Volunteer Corps in the Essex manœuvres have attracted attention in Germany, and have induced the German military authorities to direct greater attention to the subject of the military value of motors. It has been decided to extend largely the use of automobiles in the German army. During the recent German manœuvres owners of fifteen motor cars and twenty-eight motor cycles took part, and many cars and cycles were hired, the former being placed at the disposal of various staffs.

DURING the thick fog experienced last week and part of this the Sheffield Corporation Electric Light Department and the Sheffield Gas Company have had heavy demands upon them. The normal consumption of gas at this season of the year is 15,000,000 cubic feet per day, the product of 1500 tons of coal. On the 22nd inst.—to take only one day of the fog—the consumption advanced to 18,000,000 cubic feet, representing 1800 tons of coal. The extra quantity will cost consumers £250 for the day—the largest day's consumption ever recorded by the Sheffield Gas Company.

AT the Westminster Electrical Testing Laboratory a complete series of tests on all the principal makes of incandescent lamps is being carried out. There are twelve different makes of lamp being tested, and four of each make, forty-eight lamps in all. The lamps have been purchased in the open market, and they were all ordered as 200-volt 16 candle-power lamps, and of the makers' standard efficiency. The lamps are being run for 800 hours, and are being tested for candle-power and current consumption at start, and after 100, 200, 400, 600, and 800 hours' running.

WATER filtration at Pittsburg, Pa., has again been brought to the front, this time by the introduction of ten ordinances in the select council. The ordinances provide for filter beds costing £720,000; also for pumping plant, sand washers, clear water reservoir, river intake, and pipe lines, bringing the total cost of the proposed improvements up to £1,200,000. The ordinances were referred to the committee on filtration. Most of the money for this work would come from a recently authorised bond issue of £1,000,000 which is now in the courts, owing to the refusal of the city controller to advertise for bids for the bonds.

WHAT to do with our boys?—a question which has exercised the minds of parents for some time—seems about to be answered, as regards the offspring of nobility, at any rate, by an advertisement which appeared recently in the *Times*. The advertiser offers the post of motor car salesman to a young gentleman of social standing, preferably a descendant of nobility, with university education, linguist, &c. &c. The most remarkable feature of the advertisement is the absence of the usual clause with reference to the amount of capital required to be invested by the successful applicant. This would presumably follow in due course.

BY the Thames Harbour Bill, 1905, a Thames Harbour Commission is proposed to be incorporated, with twenty-four nominated and thirteen elected members. The Commissioners seek power to construct a dam, with locks, weirs, sluices, roadway, tunnel, and bridges in the borough of Gravesend and the parishes of Milton and Chadwell, commencing near the Gravesend town pier, Kent, and terminating near the World End public-house in Shadwell, Essex. Six years are allowed for the completion of the work. In the financial part of the Bill the Commissioners seek power to borrow £5,000,000 upon the security of the rents, dues and tolls.

AN acetylene gas explosion occurred in Chicago recently. The building contained a number of cylinders containing acetylene under a pressure of 240 lb. or more, several steel drums of acetone and calcium carbide, a gas generator, and a gasometer. The initial explosion killed all the employés, and was followed by several more, the final result being the death of four men, the injury of eleven more, and a property loss of £15,000. It is generally believed that the initial explosion, owing to its violence, must have been due to the ignition of the gas under high pressure in one of the tanks. Such storage is directly contrary to the rules of the National Board, which limits the pressure to 150 lb.

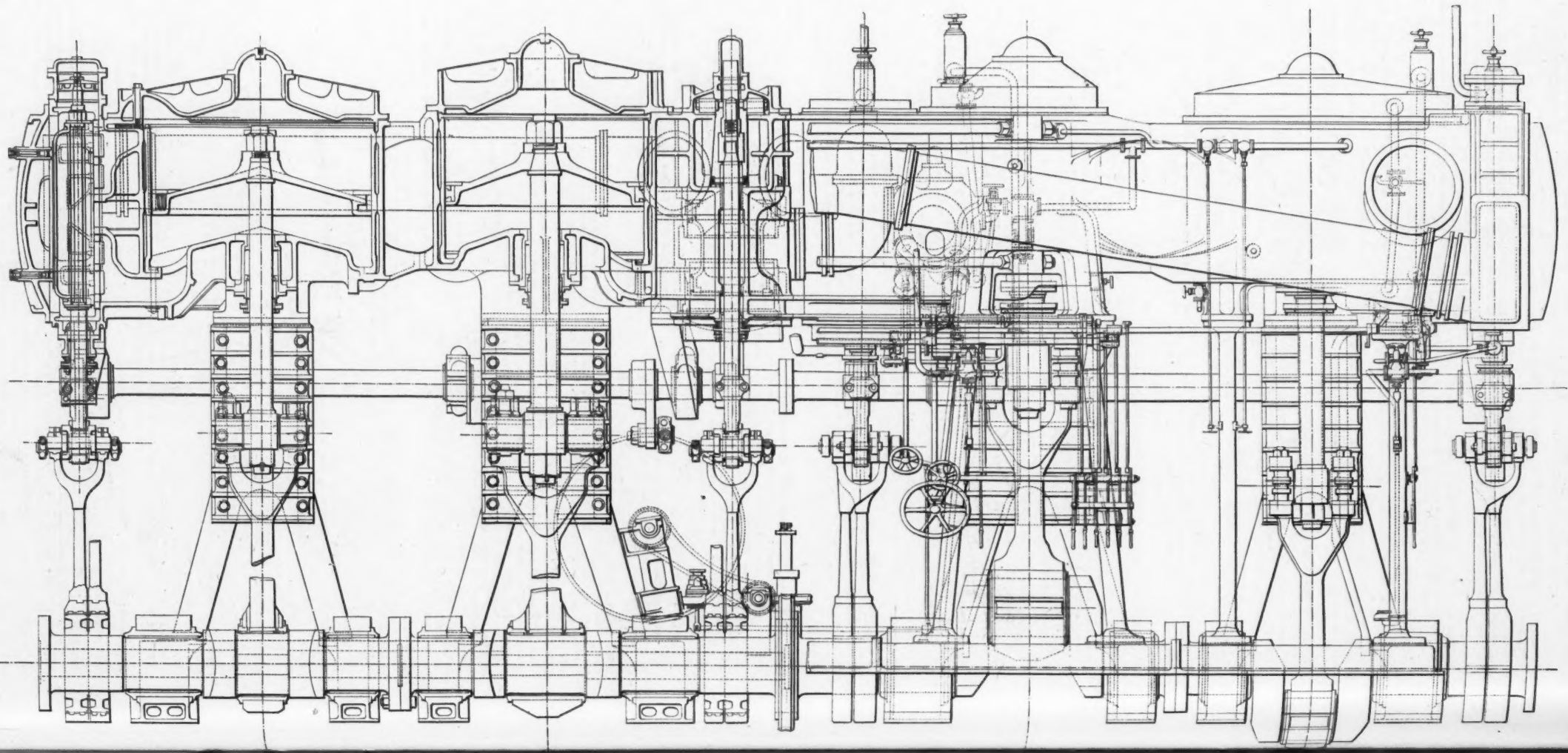
ACCORDING to the British Consul in Switzerland, it would appear that our cycle manufacturers have a fair field for trade in this country. During the last five years nearly 74,500 machines, representing a value of £655,000, have been imported into Switzerland, of which 49,500 came from Germany, 12,500 from France, 6000 from the United States, and 1700 from the United Kingdom. The imports are increasing yearly, last year's total of 17,170 machines being the highest. Some years ago the imports of British bicycles were fairly good, but during the last eight years they have been dwindling, owing to the prices being too high. The present prices ought to be low enough even for the Swiss.

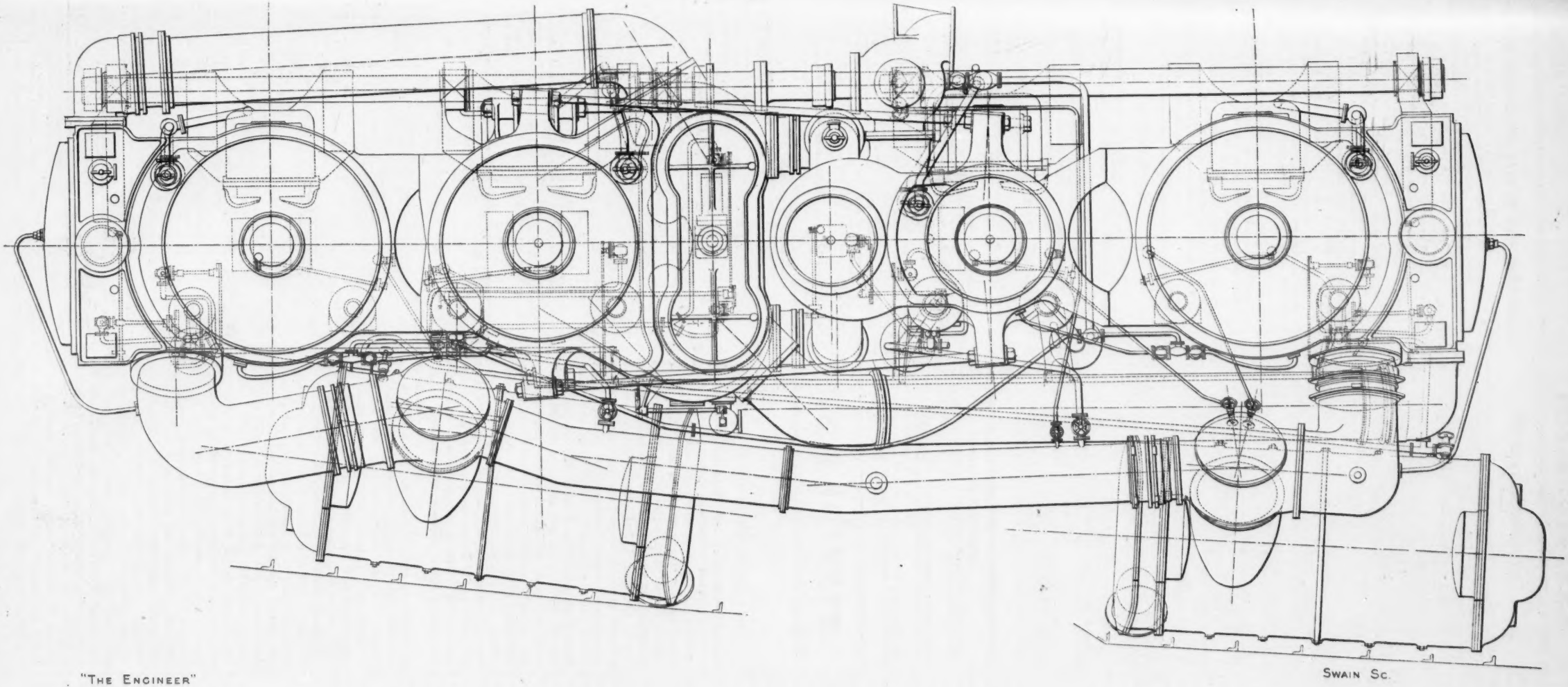
IN the course of the discussion on steam turbines at the recent meeting of the American Street Railway Association at St. Louis, Mr. C. O. Mailloux stated that in Berlin there is a triple-expansion, four-cylinder reciprocating engine of 5000 horse-power, which in running at very nearly full load has developed 1 horse-power-hour for something less than 9 lb. of water per 1 horse-power, with superheat up to 600 deg. This is possibly the best on record in steam engineering practice. However, this engine has sixteen valves, complicated mechanism, and requires a great deal of lubrication, wherefore the cost of attention, maintenance, lubrication &c., may make it really less economical in total cost than some other engines using more steam.

MAIN ENGINES OF HIS MAJESTY'S CRUISER BLACK PRINCE

THAMES IRONWORKS AND SHIPBUILDING COMPANY, LIMITED, BLACKWALL, ENGINEERS

(*For description see page* 643)





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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

C. K. H. (Farnborough).—From the Secretary, Institution of Mechanical Engineers, Storey's-gate, Westminster.

PETROL (Madrid).—We believe that there are four oil pumping stations on the Baku to Batoum pipe line. The pumps are driven by four twin-cylinder Diesel engines.

J. B. (Cornwall).—The oil pump should have 1 cubic inch displacement per 60 square inches of bearing surface, all bearings included, and should make one stroke per revolution.

B. (Ryde).—The theory which you advance, that the water in side tanks may cause oscillation by surging, is quite well known, but the tanks are so narrow and the pipes uniting them so constricted, that it is difficult to see how any dcrailing effort of magnitude could be set up.

T. B. R.—A chimney 50ft. high and 2ft. 6in. diameter ought to suffice for a boiler working up to 200 indicated horse-power. You will find a wrought iron chimney, lined with fire-brick about 10ft. up, cheaper by far than a brick stack, unless, indeed, bricks and labour are very cheap in your district.

BLOWER (Glasgow).—We have never heard of a re-enforced concrete dam. There is no reason, however, why it should not be made with success. The Ambursen Hydraulic Construction Company, of Boston, U.S.A., make what is called a concrete steel dam, but we have no knowledge of its constructive details.

METROPOLITAN.—We take it for granted that when the electrification of the line is complete the existing engines and coaches will be sold; probably bargains may be obtained. We have not heard that the company is prepared to entertain private offers for rolling stock. Why not write to the secretary and ask the question?

A. T. B. (Kilmarnock).—You might try ordinary blacklead ground up with some drying oil as an anti-corrosive paint. We do not think it can be bought ready made in this country. The Detroit Manufacturing Company, U.S.A., advertise a graphite paint, but we have had no experience with it to enable us to say whether it is good, bad, or indifferent.

MEETINGS NEXT WEEK.

RUGBY ENGINEERING SOCIETY.—Thursday, January 5th, at 8 p.m., at the Benn Building, High-street. Ordinary general meeting. Paper, "Patternmaking," by R. Watson.

THE JUNIOR INSTITUTION OF ENGINEERS.—Saturday, January 7th, at 2.30 p.m. Visit to the Voelker Incandescent Mantle Company's Factory, Albert Works, South-street, Wandsworth.

RONTGEN SOCIETY.—Thursday, January 5th, at 8.30 p.m., at 20, Hanover-square. Ordinary general meeting. "Description of an Automatic Vacuum Pump," by Mr. Charles E. S. Phillips.

THE ENGINEER.

DECEMBER 30, 1904.

ENGINEERS IN THE UNITED STATES NAVY.

IT will be remembered that for several years an agitation for the reorganisation of the *personnel* of the United States Navy was in progress, and that the final result took the form of a regulation under which all officers went through the same course, and it was taken for granted that by an automatic system of selection "executive," "deck," or "line" officers would undergo such an engine-room training that they would be competent to act in any capacity above or below deck. The scheme was looked on with such favour, indeed, that some authorities held that the only objection to it lay in the circumstance that the love of mechanics inherent in the American youth would drive so many cadets into the engine-room that the supply of executive officers could not be maintained. The system recently introduced by our own Admiralty is almost the same, and the course of events at the other side of the Atlantic accordingly possesses much interest for us, as indicating the possible result of our own experiment.

The annual report of the Chief of the Bureau of Steam Engineering for 1904 lies before us, and from it we gather that the experiment has so far been a total failure in the United States. The supply of engineers is so utterly inadequate that it is impossible to keep ships in commission and at the same time find men to take charge of the shore establishments. The engine-room is not in favour. The joint optional system will not work. While it is essential that at least 10 per cent. of the officers should perform engineering duties exclusively, not 5 per cent. are available. The United States is building up a great navy, votes will be asked for no fewer than 65,000 men, and yet at the present moment engineers are lacking for nearly every ship already afloat, and every dockyard and shore establishment. It will scarcely be credited, but it is none the less true, that the number of engineer officers borne for service on the books is only sixty-six—consisting of 8 captains, 14 commanders, and 44 lieut.-commanders, which last are alone eligible by law for sea duty. There are now no officers below this rank borne for engineering duty only. In the Navy Register for January, 1904, there are 11 battleships and 13 cruisers, with 4 other vessels of varying types and classes, each with one engineer on board, a total of 28, or 9 in excess of the number which a proper distribution of shore and sea duty would warrant. The engineering departments of the remaining 62 vessels in commission, excluding torpedo craft, are in charge of young line officers or of warrant machinists.

In times of peace, or with a stationary navy, it is possible to get on with a small staff, but it is useless to maintain a navy which cannot fight, and no navy can fight unless the ships have large numbers of engineers on board. The killing and wounding of the members of the engine-room staff must be reckoned with; and it ought not for a moment to be forgotten that the whole ship is full of machinery from end to end, which cannot be worked by untrained fighting men. It seems to be waste of time to urge upon the world facts so certain. The Russian Navy has provided an object lesson of maximum magnitude; yet for some reason very difficult to explain no sufficient measures have been taken to supply the men absolutely wanted. The recommendations of Admiral Rae, who holds a position akin to that of Sir John Durston in our own Navy, are tantamount to a condemnation of the system from which so much was expected; and which, it may be said, we are now trying in this country. Having directed attention to the defects of the system now in use, he goes on to make suggestions to which we shall come in a moment. In plain terms, reliance for a supply of engineers has been placed on volunteering. It has, as we have said, been taken for granted that young men would permanently desert the deck for the engine-room. Volunteering has turned out a dismal failure, and Admiral Rae suggests that a sufficient number of young men shall be appointed to the engine-room whether they like it or not. He does not put it so crudely as this. He would work, we gather, on the "no-compulsion-only-you-must" method. "It would be feasible," he says, "to select from the line (executive) a certain number of officers who have shown aptitude for engineering, and who desire to devote their whole time both at sea and on shore to engineering. This would remove them from being in touch with those duties which lead to command, and would necessarily render them unfitted to command. Some compensation must therefore be given to those officers for the relinquishment of this greatest of ambitions of officers—the command of ships and fleets." What form shall the compensation take? Engineers are to be retired at forty, and those who attain command rank to be exempt from sea duty and given shore appointments. It is not quite clear what "command rank" means, but we may take it that it is equivalent to what was known as chief engineer in the British Navy.

We see here that the causes which have operated to render engineering unpopular in our own fleets work to the same end at the other side of the Atlantic. We much question that, any exemption from sea duty in favour of appointments equivalent to that of a works manager, chief draughtsman, or inspector of machinery ashore, will prove sufficiently attractive to supply the requisite number of engineers. Admiral Rae proposes that all officers of the line shall be given a sufficient quantity of engineering duty on board ships in commission to render them fit to take charge of the engineering departments of any and all ships. This service is obviously to be compulsory. This becomes yet more evident when we note the further proposal: "That, for the needs of the service in the near future, the Department authorises a predetermined number of officers in the different grades to elect to be assigned to the list of officers borne for engineering duty. The fitness of the officers so electing to be determined by an examination prescribed by the Department." This is a development of the well-known system, "Catch 'em young." Plenty of men leave the schools ardently desiring service as engineers at sea. Experience teaches them, and they may find too late that the sea life is not all that they believed it to be. They would exchange to the deck if they could, but they could not under the proposed new regulations.

It is noteworthy that while Admiral Rae is advocating compulsory service at sea on the one hand, on the other he actually suggests that ships should be put out of commission. Referring to the lack of competent men to take charge of nine Navy yards, he writes, "So vital do I consider the engineering outlook for the near future that, in order to obtain a sufficient number of officers in training for these shore positions I would change, for the time being, the naval policy of the Government, or so much of that policy as renders necessary the keeping in commission of such a large fleet. If no other way can be found, it would be to the advantage of the country to place out of commission the requisite number of vessels now in service, in order to obtain the officers for this vital necessity." We do not think it is possible to pen a passage which could more completely admit the failure of present

methods to obtain engineers for the Navy of a great and enormously wealthy nation.

It must be kept in mind that the supply of officers for the navy is almost wholly drawn from the Naval Academy. It is now suggested by the New York press that there are eighty technical colleges in the country training some 15,000 students, and that Congress could get over the whole difficulty, and obtain all the men wanted, by throwing open the navy to these students. The scheme appears to be worthy of very careful consideration. It is quite clear that if the United States navy is to have any influence in international affairs a sufficient number of engineers must be provided; yet it would at the moment be easier, we think, to beat the navy at sea than to induce Congress to recognise the overwhelming importance of the engine-room staff in a modern battleship or cruiser.

MODEL TESTS FOR STEEL.

THE recent meetings at the Institution of Mechanical Engineers have brought prominently to notice the employment of shock tests for the testing of steel and the circumstances in which their use might be extended. Although steel almost, if not quite, monopolised consideration, similar tests for other materials would probably have led to equally interesting results. The type of test referred to is that in which a small sample of the material is formed into a rectangular beam and broken by a series of blows; or by one smart blow delivered either at the centre or at one end, depending on the method of support. It is then concluded that in the one case the number of blows sustained is a measure of the quality of the steel; and in the other that the kinetic energy lost by the falling tup represents that necessary to produce fracture, and therefore in its turn the degree of excellence of the material.

Before this subject can be considered to advantage it is necessary to get clear ideas as to the objects of testing materials at all. An engineering structure of some sort or shape requires to be constructed. It will when in use be stressed by certain efforts some due to static loading and some to kinetic. It is desired that the structure shall be so proportioned, without however raising prohibitively the initial cost, as to endure the severest form of loading to which it could possibly be subjected in its ordinary work. Obviously the only direct way of making certain of this is to build a similar structure and load it till it fails. This, however, is expensive, and in practice the endeavour is to arrange that models only shall be tested to destruction. In the case of, say, a bridge structure of the usual type, a cylindrical steel rod stressed by a longitudinal force is an accurate stress model of the tension members of the bridge, and imagination sees in the testing machine a reproduction on a small scale of one of the bridge ties. By moving the handle of the testing machine a whole lifetime of experience can be reproduced on a small but accurate scale. This is a case in which testing by means of stress models may be said to be thoroughly satisfactory; it owes its favourable position largely, of course, to the fact that it is the essence of the bridge designer's skill to permit of the existence of only the simplest forms of stress.

This simple kind of testing in the ordinary testing machine has occupied so large a place on the mental horizon of engineers that it has obscured somewhat the principle that all stress models must accurately and faithfully represent to scale the stresses which occur in the finished article; and that stresses of a simple nature in the model will prove useless as a guide to what occurs in the complete structure when complicated systems of stressing arise. In a stationary high-speed steam or internal combustion engine, stresses which are produced by the equivalent of blows, in that they are violent, sudden, and of short duration, are the most important considerations in design, and it is beginning to be understood that mere tensile tests provide very inadequate information. It is safe to say that an engine designed to withstand static tensile loads alone would be a very unsatisfactory machine. As another case, cast steel wheel centres may be taken. Here ordinary engineering practice demands the testing not of models only, but of the actual castings themselves. The usual tensile tests are not omitted, it is true; but with the realisation that ordinary tensile test specimens form most inadequate stress models of what occurs in the life history of a wheel centre, drop tests are made of the castings themselves. In many other cases not only is the finished article stressed, but it is stressed to destruction. Naturally in such cases only a small proportion of the materials get tested at all. Even so, the procedure is an expensive one, however necessary it may be in the light of existing methods. On grounds both of economy and general convenience it would, therefore, be a great advantage if testing on the scale of a model could be substituted.

In their recent paper read before the Institution of Mechanical Engineers, and published in our columns, Messrs. Seaton and Jude made known the very interesting results which they had obtained after carrying out a number of such tests. The specimen they used was a short beam of rectangular cross-section slightly nicked in the middle. It was supported at the ends, and a blow was given to the centre by a falling tup; this was repeated until the specimen broke, and the number of blows so delivered was taken as an index of the quality of the material. Many such tests were made, and curious anomalies were found. High tensile steels of proved ductility were shown to be quite brittle under shock tests; others, apparently similar, stood the same tests well. Doubt—grave doubt—was thereby thrown on the validity of using tensile tests as a guide in the selection of materials intended for use in machinery liable to shocks or blows. At the meeting of the Institution on December 16th, further discussion took place, and a shock-testing machine of a somewhat different form was shown. In it the specimen received one blow only, one more than enough to fracture it; moreover, the specimen was held at one end only. If the specimen were struck with a sweeping blow close to the vice it would be little more than the shearing force that would be measured; if at the end, the bending would probably lengthen the blow so much as almost to remove shock effects. In any case it is undoubtedly advisable, and this was emphasised by many speakers, that the machine and specimen should both be standardised as soon as possible, subject, of course, to sufficient consideration being given to the subject to save hastily-made conclusions from being adopted. It is almost impossible to compare effectively shock tests carried out on different machines or in different circumstances. Values found by methods of inter or extrapolation are rightly looked upon with the greatest suspicion.

As in their lifetimes finished structures are not subjected to one shock or blow only, it would appear advisable, having regard to the ideas underlying the testing of stress models, that specimens should be broken with a series of blows rather than by one only. It would be quite easy to devise a machine which would automatically deliver sufficient blows to break the specimen, register the number of them, and then feed in a fresh specimen. The form of specimen, the notching or screw-cutting, the effect of holding the specimen at one end only, and other matters, all require and should receive the most careful consideration. The effect of notches or scratches on specimens or finished articles as affecting their ability to withstand stress is not at all understood. A not dissimilar case is that of a shaft stressed by torsion, in which a keyway has been cut. The investigations of a celebrated mathematician seemed to show that the effect of cutting a keyway must be to reduce gravely the torsional strength of a shaft. It has, however, since been shown by another mathematician, in the light of fuller knowledge that the effect has been greatly exaggerated, and that although it is true that at the sharp corners of a keyway the stress becomes infinite, yet, on the other hand, the area affected is infinitely small, and the tiniest amount of plastic yielding at the corners is enough to prevent any ill-effect.

To follow exactly what occurs when a small beam specimen is broken by a blow at its centre is certainly difficult. Immediately the blow is given, or begins to be given, a semi-spherical elastic disturbance spreads out in wave form from the point of impact. This wave of compression is reflected on reaching the opposite boundaries, and a complicated kind of shiver travels through and along the specimen. At the same time, secondary disturbances spread out from the points of support. The shivering rapidly dies away, and the resistance offered to further deformation becomes what is known as static. Obviously a great deal depends upon whether the tup "gets in" its blow before the shivering has stopped. Having regard to the velocity with which sound travels in a steel rod, probably it does not, and the phenomenon becomes simply that of a series of static forces rapidly applied. Were the blow able to take full effect before the specimen had reached a nearly or quite steady state, it might be expected that the bar would snap off sharply, on the same principle that a candle fired from a fowling-piece penetrates the wooden panel of a door. Probably the specimen breaks owing to excessive tension on the under side. The tension would be proportional to the maximum force exerted by the tup during impact, and as the blow is measured by the loss of momentum, so is its force by the rate of that loss. It therefore follows that in a machine in which the tup is brought to rest from a velocity due to a fixed height the maximum stress on the under side of the specimen will depend upon the time of duration of the blow, and in turn on the distance penetrated by the striking point of the tup. This distance will be made up of the deflection proper of the beam, the elastic deformation at the immediate point of impact, and the plastic deformation at the same point. From these considerations it seems possible to see what happens. A bar with a very high yield point may not appreciably be stressed at, or near, the point of impact beyond its limit of elasticity, and in that case the tup will be brought up sharp. This would result in a very considerable tensile stress being thrown on the under side of the bar; fracture would then be likely to occur. Evidently this effect could arise whether the bar were ductile or not, whether the reduction of area were large or not, and the fact that a steel showed good tensile tests would be no guarantee that it would withstand such shock tests. We are far from pretending that this explains all, or even most, of the difficulties connected with this subject, but it seems to be a reasonable line of argument. It is worthy of note that experiment does rather tend to show that bars which have their yield points low in proportion to their stress limits stand well under shock tests.

It will be admitted generally that the subject is one of importance, and one which deserves very careful consideration. It is to be hoped, however, that any experiments which may be undertaken, either by private individuals or public bodies, will be carried out in an impartial spirit, and not hindered in any way by preconceived notions as to what ought to occur.

CARELESS WORKING ON RAILWAYS.

WE trust that the gradually less frequent appearance of Board of Trade reports on railway accidents is proof of greater immunity from mishap. Year by year the number of inquiries held by the inspecting officers has gradually decreased. During 1900 there were 64; 1901, 44; 1902, 37; 1903, 31. Up to June 30th of this year there had been 12. Six reports have since been issued, and allowing for six up to the end of the year, that would make 24 for the current year. These figures compare with ten years ago as follows:—1890, 53; 1891, 68; 1892, 48; 1893, 46; 1894, 35. These figures are not absolute proof that there have been less accidents, as an inquiry is not held into every accident. The Board of Trade consider the facts of each case as submitted by the railway companies, and they only inquire into those cases where there are personal injuries, or where some improvement in working or accommodation seems to be called for, or where there seems to be dereliction of duty or loose administration. As the number of inspecting officers is the same as ten years ago, and as their duties as to new lines, &c., are less, if anything, these figures must mean that railway accidents are fewer, although there may be no decrease in the number of passengers and railway servants killed and injured. Two recently issued reports would appear to show that the number of accidents would be still less were it not for the mental aberrations which sometimes befal railway servants. For several years railway companies have been spending large sums of money on signalling and safety appliances whereby it is guaranteed that the signals cannot be lowered for a train unless all the points over which the train has to pass are in their proper position. At East Linton Station, on the North British Railway, all points and signals are interlocked, and the place is apparently complete in that respect. On the afternoon of September 12th last the signalman there turned a goods train off the down main line into the down loop through a set of facing points that are practically opposite the signal-box. Immediately afterwards a down express was accepted by the signalman, who found that only the starting signals in advance of the points could be lowered, while the inner and outer main line home signals would not come off. This would naturally point to the facing points still lying for the loop line, and the signalman states he thought so, and he then reversed the lever working those points, and pulled them over again, and yet the signals could not be lowered, so he went out of the box and examined the connections on the inner home signal, but failed to find anything amiss. According to rule, he should then have taken certain action, which would probably have led to the cause being discovered; but, instead, he acted in a very foolish—nay, a culpable—way. He himself lifted the weight of the inner signal, and pinned it off, and got a platelayer to hold the outer signal off. The express came along, and, needless to say, went into the loop and came into collision with the tail of the goods train. The effects were not serious, owing to speed having been reduced as the distant signal was on—it was too far away to be tampered with—and the driver was exceedingly smart in noticing where he was being turned, and quickly applied the Westinghouse brake. It is, perhaps, unnecessary to add that no defect was found in the points or signals. The other case was on the Barry Railway, on October 6th, and arose from a stupid error in block working, coupled with a breach of rules on the part of an unfortunate driver—who was killed. The signalman, after having accepted a train, commenced shunting operations, and fouled the line. The driver, when approaching the box, found the two junction distant signal lights out, and subsequently only one of the junction home signal lights burning. He apparently assumed that the distant and home signal for his direction were off, and proceeded, only to come into collision with the

shunting train. He, poor fellow, jumped from his engine, and was crushed by a wagon derailed in the collision. The signalman was the original sinner, as he ought not to have allowed the shunting train to move after having accepted the other train, and the driver, when he found the signal lights out, should have treated them as signals at danger. Happily the general run of railway servant is of a superior type, with a thinking mind, capable of grasping the position of affairs, not in the least inclined to take chances, like his American cousin, and yet able to take prompt action in case of accident, and to these men is to be ascribed the great immunity from mishap on British railways.

ELECTRIC RAILWAY COACHES.

THE type of coach which is being used on the electrified part of the Metropolitan Railway system raises again the vexed question of the most economical form of railway passenger carriage. The difficulties of designing a coach that will meet the conditions are by no means easy of solution. In view of the great press of traffic at certain hours of the day, it is important that the trains should have large capacity, and as the stops at stations must be of minimum duration, it is necessary also to be able to take up and set down passengers rapidly and easily. It is believed that the only type of coach which meets these conditions is one with doors at each end and large standing room. The travelling public probably imagines that when they pay for their tickets they have a right to seats. The rapid transit railway official will assure them that they are mistaken; and that whilst the railway company must carry them, it is no more obliged to provide seats for them to sit on than it is to find accommodation for the half-hundredweight of luggage that they are permitted to take. Whether this point of view could be sustained in a Court of law is, our legal correspondent shows in another place, open to a little doubt. In any case, the public elect to stand rather than be left behind, and because more can stand than could be provided with seats they do not insist on the fact that, if the seats were arranged otherwise, from 30 to 50 per cent. more people might be accommodated. The question of ingress and egress, too, is one of great moment, and yet is not frequently discussed. It is generally accepted that entrance and exit must take place by end doors only, and it is the aim to admit always by one and to discharge by the other. A moment's reflection will show that in a crowded compartment it is not possible to adhere rigidly to that rule if the stop at a station is never to exceed 30 seconds. To ask a passenger—the last comer at a previous station, perhaps, to make his way through a long corridor carriage—with every seat occupied and the gangways full—in half a minute is to ask an impossibility. This raises the question whether the long coach with only end doors is the correct solution, and whether various modifications that have been suggested have been properly tried. Some time ago—September 25th, 1903—we illustrated a side-door coach built for the Illinois Central Railway. We have not heard whether the design has been repeated. It had sliding doors opened and closed automatically, which seemed to present a serious element of danger; but who that remembers the outcry against inside handles in carriages will accept hastily a criticism which has proved so entirely false in the parallel case? On the Great Northern and City Tube sliding side doors are provided as well as end doors. Many of the dangers of the sliding doors may be overcome by cushioning the last few inches of their movement. But granting that even the side door and separate compartment is unsuitable, is the present coach the best solution of the problem? Would not two side doors for entrance, and two end doors for exit, for example, be better?

TURBINE ATLANTIC LINERS.

THERE was launched on the 22nd inst. from the stocks of Alex. Stephen and Son, Linthouse, Glasgow, the new Allan liner Virginian, of 11,200 tons, which that firm was commissioned to construct at the latter end of last year, shortly after the order for a similar vessel was placed with Workman, Clark and Co., Belfast. The latter vessel, the Victorian, was sent off the stocks on August 25th last, and is at present fitting out for sea. Both these vessels, as is well known, are to be propelled by Parsons' steam turbines, instead of the ordinary reciprocating engines, and as they will be the first turbine liners to engage in the Transatlantic service, and will thus mark a highly important advance in the application of the steam turbine to ship propulsion, great interest is centred in their progress towards completion. When that is accomplished the vessels will be placed on the Canadian mail and passenger service from Liverpool; the Victorian sailing on her maiden voyage to Halifax, Nova Scotia, and St. John, N.B., on March 23rd, and the Virginian for the same ports on April 6th.

Although the Atlantic has already been navigated by several turbine steamers—*e.g.*, the Turbinia, built on the Tyne, now engaged in lake service, and the yacht Emerald, built by the Linthouse firm, and absolutely the first turbine steamer to cross—the fact of the Virginian being one of the two pioneer regular turbine liners, and also of the vessel being the heaviest yet sent off the stocks at Linthouse, made the launch one of exceptional interest even on the Clyde, where large mail and passenger vessels being consigned to the water forms no great novelty. A large concourse of spectators watched the event, which was entirely successful, the naming ceremony being performed by Miss Eleanor Allan, Glasgow.

The Virginian's dimensions are:—540ft. length over all, 60ft. beam, and 41ft. depth. She has been constructed under the supervision of Messrs. Allan's representatives, Mr. A. M. Gordon and Mr. David Johnstone, to the highest class in the British Corporation Registry, and to the passenger requirements of both the British Board of Trade and the American laws. She has accommodation for about 1650 passengers—470 first-class, 240 second-class, and 940 third-class. The vessel has a poop, long bridge, and forecastle, with large houses in the wells between the hatches, the tops of the poop and houses being arranged as promenades for passengers and sheltered by boat decks, which again form promenades sheltered by awnings. On the bridge deck is a long deck-house containing first-class state-rooms, with a wide alleyway on each side; above is the promenade deck, with deck-houses containing the first-class music and other saloons, sheltered by the boat deck above, which is itself a wide promenade, having the officers' quarters and navigation bridge at the fore end, and on each side a range of boats the full length of the deck. The vessel is specially designed for the conveyance of the Canadian mails and passengers, no fewer than five decks being fitted up for the accommodation of the latter, and that accommodation, it is almost needless to say, is conceived, and will be carried out, on lines which will afford every comfort and luxury that modern skill and forethought can provide. The Virginian has also good cargo space fore and aft, and is divided by bulkheads into eleven holds, and with the sub-division of her water-tight double bottom she has twenty water-tight compartments. Her hull has been specially strengthened above the requirements of the British Corporation in order to make her doubly secure against the heavy weather of the North Atlantic. Every provision has been made for minimising the discomforts sometimes experienced in this connection, and the cabin accommodation is heated throughout by steam, the pipes being so arranged that each individual passenger can modify the heat to suit himself. The emigrants are kept comfortable by an installation of the thermo-tank system, which combines the duties of heating and ventilation. Electric light is fitted throughout, and there is also an installation of the Marconi telegraph.

The feature of outstanding interest, of course, about the Virginian, as of her sister ship, is the turbine machinery. In the case of the Virginian the turbines are being supplied by the Parsons Marine Steam Turbine Company, Wallsend-on-Tyne, while the boilers—nine single-ended, and worked under forced draught—together with a very complete installation of auxiliary machinery, are being supplied from the engine works of the builders—Alex. Stephen and Sons, Limited—themselves. The propulsive power is to be transmitted through three lines of shafting, triple screw propulsion of itself being a step almost novel in Transatlantic service, each fitted with one propeller of dimensions which, of course, strike us as puny for their duty as compared with the propellers of ordinary single and twin-screw ocean liners. The revolutions are, however, abnormal from this point of view, being estimated at 270 to 300 per minute when the vessel is going full speed, which in ordinary service is to be 17 knots, meaning about 18 or 19 knots under trial trip conditions.

The central line of shafting, arranged as in a single-screw vessel, is worked by a high-pressure turbine, the others, which are arranged as in a twin-screw ship, by low-pressure turbines. The two latter have each a reversing arrangement, which enables them to be at once driven astern, either together or independently. The ship will thus be as easily and effectively manœuvred as regards backing or turning as an ordinary twin-screw vessel.

Regarding this reversing and manœuvring power, it is not the case, as has been reported, that the Parsons Company has devised a special arrangement for these liners. The arrangement followed is the same as that adopted with success in the turbine-propelled Channel steamers. The astern turbines are placed in the exhaust casing of each of the low-pressure turbines, and, when manœuvring, steam is admitted into the low-pressure turbines or the astern turbines, for going ahead or astern as may be required, independently of each other and the high-pressure turbine. A noticeable feature in the power of the astern turbines for quickly stopping a vessel was seen when the turbine steamer The Queen was stopped in two and a-half times her own length when going at a speed of 19 knots.

Speaking of the importance of great stopping and reversing power for manœuvring purposes in ocean liners of high speed, at the luncheon which followed the launch of the Virginian, Mr. Nathaniel Dunlop, managing director of the Allan Line, said that Mr. Parsons had examined the problem and satisfied both himself and the owners and builders that it could be solved. They had no hesitation in accepting his assurance, and nothing had occurred in the process of construction to disturb their confidence in the system. He made this statement because a paragraph appeared some time ago in the American press, and was reproduced in our own, to the effect that the turbines had not answered the expectations of the Allan Line, and had not come up to the contract power. That statement was actually issued before the turbines were made, and before any trials of their power were possible. The turbine system promised many advantages to travellers by sea, its noiseless and uniform motion imparting a corresponding measure of steadiness to the ship in heavy weather. The speed, too, of these turbine vessels on the Atlantic would reduce the time at sea, and, together with the shorter mileage of the Canadian route and its land-sheltered navigation on the Canadian side, should make it a favourable line to travel by to and from the American continent.

SEATING ACCOMMODATION IN RAILWAY CARRIAGES.

(By a Legal Correspondent.)

A QUESTION of some interest to the travelling public is likely to arise when the Metropolitan Railway becomes electrified. It appears that, although the carriages which are to be used are to be better lighted and more comfortable than those now running, the seating capacity of the trains will be very much reduced. In these circumstances it is of interest to inquire whether and how far a railway company is bound to provide seats for passengers. Could the District Railway Company, for instance, be compelled to construct the new coaches in such a way that they will be at least as commodious for seating purposes as the compartment carriages which are to be supplanted?

In order to obtain some light upon this question it is necessary to refer to the Cheap Trains Act, which was passed in the year 1844. That Act was passed with the object of compelling the railway companies to provide a certain minimum of trains with the accommodation suitable for third-class passengers. The train so provided soon became to be known as parliamentary trains, but in view of the extraordinary development of third-class traffic on all the great lines, nearly every train which now runs is "parliamentary" in the sense that it provides third-class carriages.

By Section 6 of the Act of 1844 it was provided that:—"The carriages in which passengers shall be conveyed by 'such train' shall be provided with seats, and shall be protected from the weather in a manner satisfactory to the committee." This section has not been repealed, and the Board of Trade has taken the place of the committee. Did this section stand alone it might now be argued that at the present day every railway company is bound by statute to run at least one train "each way" daily, provided with seats. It seems, however, that by Section 8 of the Cheap Trains Act, the Board of Trade might, if they thought it right to make such an extraordinary order, dispense with the necessity of providing seats. The effect of that section is that except as to the amount of fare or charge for each passenger by a cheap train, which must in no case exceed the rate of 1d. per mile, the Board of Trade have a discretionary power, upon the application of any railway company, of dispensing with any of the conditions hereinbefore required, in regard to the conveyance of passengers by such cheap trains as aforesaid, in consideration of such other arrangements, either in regard to speed, covering from the weather, seats, or other particulars, as to the Board of Trade shall appear more beneficial and convenient for the passengers by such cheap trains under the circumstances of the case, and shall be sanctioned by them accordingly; and any railway company which shall conform to such other conditions as shall be so sanctioned by the Lords of the said committee—now the Board of Trade—shall not be liable to any penalty for not observing the conditions which have been so dispensed with by the Board of Trade in regard to the said cheap trains and the passengers conveyed thereby. It has been suggested that where there is one train satisfying the requirements of a cheap train as to seating accommodation, &c., the Board of Trade may, under the above section, dispense with the conditions in the case of additional cheap trains (A. G. *v.* North London Railway Company, 1 A.C. 148.) Of course, it is not to be supposed that any railway company would ever have the temerity to ask to be allowed to dispense with seats altogether, or that the Board of Trade would ever grant such an application. At the same time it appears to be reasonable to draw the inference that if the Board of Trade are satisfied that an improved system will enable the company to run more trains, they will look upon the diminished number of seats as a matter of minor importance. At the same time, it is conceived that the effect of the statute law relating to railways is that the companies are not under any liability to provide seats except in parliamentary trains.

It remains, however, to consider whether, by permitting passengers to stand up in carriages, a railway company becomes exposed to any other risk. How far a passenger who is unable to obtain a seat is entitled to sue for breach of contract it is impossible to state with any authority, as the point has not been decided. It would seem, however, that all the railway company undertakes to do for the passenger is to provide the best accommodation it can. If overcrowding is permitted, the company becomes exposed to some risk, for it has been decided, or, at any rate, stated in the House of Lords, that if passengers are allowed to stand up in carriages, this may be held to be the result of negligence on the part of the company's servants in allowing the carriages to be overcrowded. A curious case which was heard in 1887 may serve to illustrate our meaning. One Jackson was a passenger on the Metropolitan Railway. The carriage in which he rode was full. At the Gower-street Station—there being a great demand for seats—three persons forced themselves, and were obliged to stand. At Portland-road there was a rush of more passengers, and, in order to prevent them entering, Jackson stood up and extended his arms and hands across the carriage, and as the train was moving on, put his hand on the lintel of the door to steady himself. When the door was being shut by a porter his thumb was crushed. He brought an action against the company for negligence. In the Court of first instance a jury awarded him £50 damages, but this verdict was set aside by the House of Lords, Lord Cairns saying:—"In the present case there was, no doubt, negligence on the part of the company's servants in allowing more passengers than the proper number to enter at the Gower-street Station; and it may also have been negligence, if they saw those supernumerary passengers, or if they ought to have seen them, at Portland-road, not to have then removed them; but there is nothing, in my opinion, in this negligence which connects itself with the accident that took place." This decision cannot be regarded as a very satisfactory authority at the present day, or as applied to electric corridor trains; for the practice of standing up in these carriages has become so common that persons who enter them and travel in this manner may well be assumed to have taken all the attendant risks. It is conceived that if the question ever arises as to whether electric railway companies ought to provide seats for all their passengers the consideration that (1) the practice of standing up causes but slight inconvenience to those who are seated, (2) that those who stand up willingly take the risk of so doing, will have a considerable bearing upon the decision of the matter, whether by the Board of Trade or by the Railway and Canal Commissioners, if, indeed, it is possible to bring the matter before the latter body.

THE RAILWAY COAL CONTRACTS.

THE fact that the Midland and North-Eastern Railway companies have accepted the amended tenders of the South Yorkshire coalowners at 8s. 3d. per ton, and in both instances for twelve months, has caused considerable satisfaction in the colliery districts The change brought about by the Lancashire and Yorkshire Railway Company caused quite a panic for a time and considerable dislocation of traffic. It is believed the Great Northern Railway Company will also accept the coalowners' tenders. Colliery proprietors consider the price none too high, considering the quality of the coal they have to offer. The Lancashire and Yorkshire has not proceeded further than the placing of 2500 tons at a Barnsley colliery, at, it is understood, 8s. per ton, and they will now probably have to pay 8s. 3d. for the best steam coal. The placing of the tenders is always hailed with satisfaction, as the price usually controls spring and other prices. So far as can be ascertained, the contracts have been distributed over much the same area as other years; and being placed for twelve months, coalowners who are fortunate to obtain the contracts will be able to make their arrangements with greater safety.

THE year's receipts of the Sheffield city tramways have been £235,939. Last year they were £228,743. In previous years the income was considerably less.

ELECTRICALLY-DRIVEN TRANSPORTERS

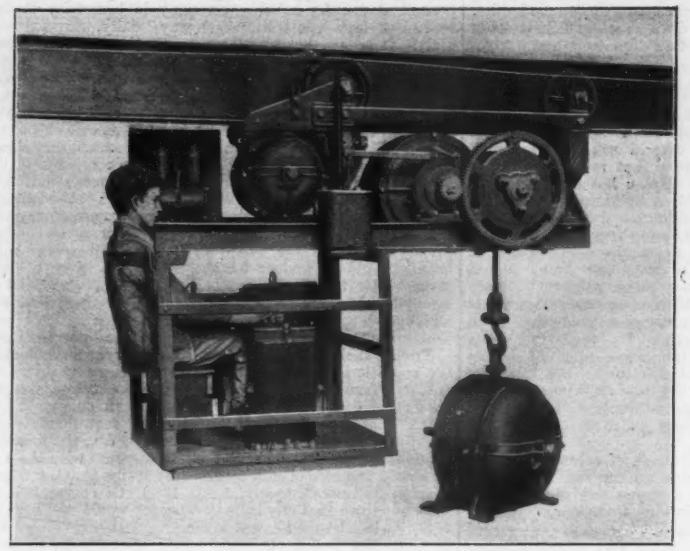


Fig. 1

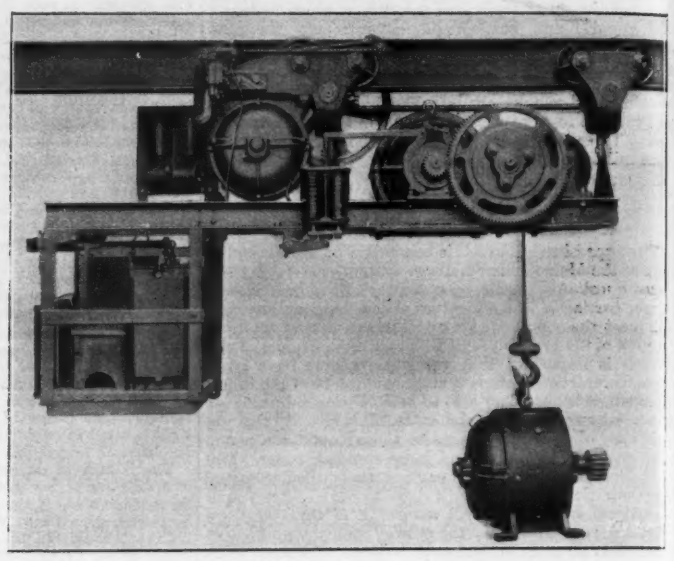


Fig. 2

ELECTRICALLY-DRIVEN TRANSPORTERS.

THE question of the quick transportation of raw material or finished articles from one part of a works to another has, of late years, received much more attention than was formerly the case. The advent of the electric motor simplified the matter. The older methods are fast disappearing. The hand-driven overhead travelling crane is almost a thing of the past. For this sort of work electricity has proved itself eminently suitable, and another appliance in which electric driving mechanism has been successfully employed, is the transporter. Many of our readers will remember the electrically-driven luggage transporter which has for some years now been in operation at Victoria Station, Manchester. To-day we are enabled, by the courtesy of Messrs. Royce, Limited, of Hulme, Manchester, to give engravings of three forms of electrically-driven transporters which this firm has put upon the market. All of these will be seen to possess

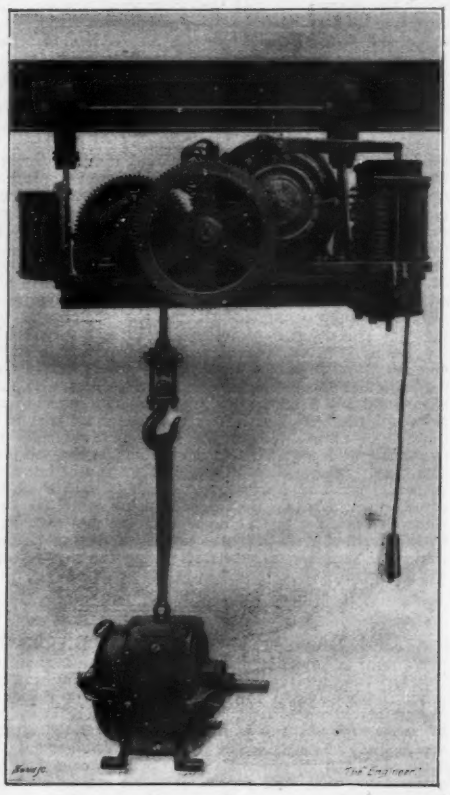


Fig 3

interesting features. To take the simplest of the three, namely, that shown in Fig. 3, it will be seen that it is hung from two pairs of trolley wheels, these being kept apart by distance rods and running on an ordinary I joist. From the brackets carrying these two hang the supports for the mechanism platform, this latter being made up of steel joists. The mechanism, as will be seen, consists of an electric motor driving the hoisting gear through double reduction gearing. The motor spindle is provided with a brake wheel, which is embraced by a brake band, automatically worked by means of the electro-magnet. Behind this is the controller. The current can be collected in any convenient way. It will be observed that the whole of the mechanism can swing, so that there should not be any cross strains when lifting a weight which is not directly under the transporter. When the load is suspended the moving about is done by hand.

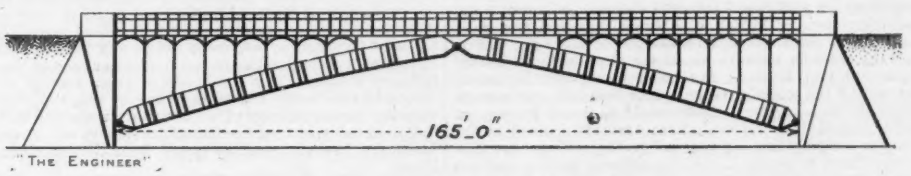
Another and more elaborate form of transporter is shown in Fig. 1. In this, besides the hoisting motor, the propelling is brought about by another motor. This type of transporter is usually made for loads of from 10 cwt. to 15 cwt., but Messrs. Royce inform us that the type can be adapted for dealing with loads up to 5 tons. The engraving shows a transporter made for use on a straight track. It is therefore rigid from end to end. The driving cage is suspended below it, and the various controlling devices arranged conveniently in it. The arrangement of the whole apparatus is so readily to be understood from the engraving that no further description is necessary.

In Fig. 2 is shown a transporter capable of travelling along curved rails. For this purpose bogies are provided and are made to swivel. In Fig. 1 it will be observed that single-running wheels only are used. The bogies in Fig. 2 are connected together by a linking bar. The mechanism is practically the same as in Fig. 1. In both cases there is an automatic magnetic brake, which, when necessary, can be manipulated by hand. There is also an overwinding safeguard, so that the gearing shall not be broken if the load is lifted too high.

The advantages which the makers claim for these transporters are that by them materials can be conveniently and rapidly handled; that direct transference of material from one point to another is possible; they are cheap in first cost; they occupy a small space; the cost of current and attention is small; the transporter beam can be carried from a workshop wall or from any convenient position on the roof principals; loads can be taken up or deposited at any point; and that the speeds of hoisting and travelling are quick.

CONCRETE BRIDGE OVER THE NECKAR.

IN certain portions of the German Empire the practice of building the abutments of arch brigdes as virtual prolongations of the arches themselves is of almost universal application. A very recent instance of the adoption of this method is that of a road bridge over the river Neckar, near Neckarhausen. This structure consists of a single three-hinged concrete arch, shown in the accompanying sketch elevation.



CONCRETE BRIDGE AT NECKARHAUSEN

It has a span of 165ft., which is large for the material employed, and a rise of 13½ft. There is a roadway, 14ft. 6in., and two narrow footpaths, carried upon arches supported by small rectangular concrete pillars forming a system of open spandrils. At the crown the thickness of the main arch is 2·8ft., towards the haunches 4ft., and at the springings 3ft. In cross section the width of the arch widens out from 15·8ft. at the centre of the span, to 18·5ft. at the bearings. The springings are placed 5·8ft. below the level of flood water, and consequently at a small height above the ground, thus rendering the real abutments invisible in the sketch. As the substratum was composed of magnesian marl intermixed with clay, a greater proportional width was given to the abutments than thickness, so as to provide for any possible earth slips.

At a depth of 26·4ft. to 23·8ft. below the level of the springings were laid the foundations, with a thickness of 20ft. to 27ft., and a width of 31·6ft., or double that at the crown of the arch. If the span be taken at this level, which is the termination of the prolongation of the arch, which abuts normally on the footings, it will be found to measure 205ft. Upon these foundations are also built vertical retaining walls, answering in appearance to the ordinary bridge abutments, and flanked by the usual splayed wings, raked to suit the slope of the bank. The articulations, both at the crown of the arch and over the supports, consist of cast iron shoes, to the number of seven and nine respectively, bearing upon intermediate steel pins, 4in. in diameter and 20in. in length.

Cement concrete is exclusively used for the whole body of the work, including the faces of the arches, which are built in imitation of granite, relieved by artificial representations of red sandstone. It has long been recognised that in dealing with structures of armoured as well as of unarmoured concrete, it is absolutely indispensable to study their appearance when they assume the *rôle* of public works. It is true that a very fair surface can be given to cement concrete without the necessity of employing any elaborate means or extra material. Facing of this description answers well enough for ordinary walling, and some kinds of underground edifices, but not in the case of more pretentious designs. The composition of the concrete in the Neckar bridge varies according to the position it occupies.

In the foundations the proportions of the different ingredients by volume are one of cement, three of sand, and six of gravel. For the pillars and small arches of the spandrils the proportions of the cement and sand are the same as for the foundations, but the gravel is replaced by the same volume of broken stone. One of cement, two and a-half of sand, and five of broken stone are used in the main arch and roadway, and for the artificial stones the two latter ingredients are two and four in volume. The sand was obtained from the crushing of porphyry or limestone, as experiments have proved that, produced in this manner, it is superior to the natural article in the resistance it imparts to the concrete. It has been assumed, in accordance with the general rule, that it is unnecessary to make any allowance for stresses in the concrete of a tensile character. For those of compression 570 lb. per square inch is the limiting unit. The bridge itself was designed to carry a steam - ad roller weighing 15 tons, and a uniform loading of 80 lb. per square foot on the footpaths. Continental nations generally adopt a lower unit stress in this latter respect than ourselves. In the erection of the centering a camber of 8in. was given to it, but the subsequent deflections showed the amount to be much in excess of that required. During the construction of the arch, which was accomplished in nine days, the maximum drop did not exceed 2⅜in., and the striking of the centers, a couple of months after the keying in, added but an additional ⅛in. The total permanent deflection at the crown amounted to 4½in., and the successive risings and fallings, due to the difference of temperature in summer and winter, revealed an amplitude of 1¼in. No permanent sag was developed by the testing operations. According to *Zeitschrift für Bauwesen*, 1903, the total cost of the bridge was £3520, or at the rate of £1 5s. per square foot. The plans of the structure were prepared by M. Max Leibbrand, and the works were carried out by the firm of Wayss and Freytag of Neustadt.

OBITUARY.

J. MACKENZIE BACON.

THE scientific world will regret the death of the Rev. J. Mackenzie Bacon, who died on Christmas night, aged fifty eight, of pleurisy, at Coldash, near Newbury. Mr. Bacon was, perhaps, the greatest aëronaut in the world, and his attainments as a meteorologist and an astronomer were very high. He assisted in three eclipse expeditions of the Astronomical Society in 1896, 1898, and 1900. He was specially interested in the upper air, which he diligently explored by constant balloon ascents, frequently accompanied by his daughter. As a lecturer he enjoyed much popularity. Two years ago he published "By Land and Sky: the Dominion of the Air," and he was the author of numerous scientific and other papers.

The death is reported of Mr. William George Laws, late city engineer at Newcastle-on-Tyne. His age was 68 years.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

TANK ENGINE DERAILMENTS.

SIR,—From the article which appears in your last issue, page 624, it appears that your contemporary, the *Railway Review*, has published some remarks upon tank engine derailments.

As I have not read your contemporary, I do not know its views, but I desire to reply to that part of your article which refers to my letter which appeared in your issue of 16th December, page 605.

During the past twenty-five years I have given evidence at various inquests and Courts as to the causes of tank engine derailments, the last instance being, of course, the Llanelly disaster.

In your article you hope to elicit information, and this is the sole cause why I am now writing; but I can give no more information in this letter than I have given over and over again in the witness-box under examination and cross-examination.

Turning to the article, in the first place I use the word "oscillate" because it is used by railway engineers and the Board of Trade inspectors, and it is much more clear, to my mind, than "rocking," "wandering," or any other word. Practically the whole of the questions which you raise in your article have already been put to me by coroners, Board of Trade inspectors, and counsel on many occasions, and turning to the reports I find the following:—Q.—Which type of engine is the most steady, tender or tank? A.—The tender engine, decidedly. Q.—Why? A.—Because the tender engine has a heavy tender coupled closely to it, which controls its oscillations; but the tank engine has no such tender.

I have travelled upon a six-wheeled coupled goods tender engine at a high rate of speed; but a tank engine of similar dimensions oscillated so much when it reached a speed of 40 miles an hour that the driver shut off steam and said it was not safe.

Another question put by a coroner was:—Q.—Is a tank engine more liable to run off the line at high speed than a tender engine? A. Yes, it is—due to oscillations, which results from the absence of the tender.

Mr. Kirtley, the locomotive engineer of the Midland Railway, made some practical experiments on the subject. He ran an engine and tender at a series of speeds, and observed the "oscillation"; then he had the tender uncoupled and removed, and the result was so clearly demonstrated that he was always strongly opposed to tank engines, except for shunting, and for running the local trains in the London district. Q.—What is your opinion of saddle tank engines? A.—Saddle tank engines are especially unsafe at high speed, not so much on account of the height of the engine, but from the fact that the oscillation of the water in the tank alters the horizontal centre of gravity of the engine from in front of the driving axle to the back of that axle.

I have made experiments with spirit levels, and a pendulum instrument placed on the frame over the centre of the driving axle, and the way in which the centre of gravity was thrown for a few seconds behind the driving axle was very clearly demonstrated.

The fact that the oscillation of a tank engine causes the centre of gravity to be thrown behind the driving axle, reduces the weight on the leading wheels, and thus permits the flange of the leading wheel to be forced up on to the top of the rail, and then over on the wrong side.

At the Llanrwst accident last July I found that the oscillation of the tank engine finally "burst the road," and the wheels fell into what should be the four-foot; but in the Llanelly case the result was different, the oscillation of the engine threw the centre of gravity behind the driving axle, thus relieving the leading wheels of some of their weight, with the result that the right leading wheel flange was forced up on to the right-hand rail, and fell over on the wrong side.

I have known twelve cases of tank engines in good order getting off the line, also in good order, and, as I replied to the question of the coroner, "If these twelve trains had been drawn by tender engines the accidents would not have taken place."

As the question of tank engines and accidents is to be raised in Parliament early next session, it is important that the facts of the case should be elicited, and I trust that the necessary steps will be taken to prevent the occurrence of similar disasters from the same cause.

Of course it is easy to understand that the drivers and firemen and the *Railway Review* take very great interest in this question, because when a tender engine gets off the line the men on the engine may escape with their lives, but when a tank engine runs off the driver and fireman are almost certain to be killed, as was the case at Llanelly.

Another point of view which is not mentioned in your article is the loss to shareholders due to tank engine derailments.

At Llanelly the sole cause why a goods shunting tank engine was sent to assist the express instead of a tender engine was that the engine was afterwards required to do shunting at Gowerton.

A few shillings were thus saved in the running of a shunting engine, but on the other hand there is the damage caused by the accident to engines, coaches, and permanent way. There is all the legal expense, and the vast compensation which is having to be paid to the relatives and injured.

So that from a shareholder's point of view tank engines on fast trains do not pay, and to my mind that is a very serious indictment against them.

Saxe-Coburg House, CLEMENT E. STRETTON.
Leicester, December 24th.

SIR,—Arguing on the available facts, it is easy to show that tender engines are more liable to leave the rails than tank engines are by at least five to one.

It seems that only one derailment of a tank engine takes place in every three years and nine months, whereas several derailments of tender engines take place every year.

I myself hold that tank engines should not be run at high speeds, but my reason for this is not that they are tank engines, but that they have wheels much too small for high speeds, the reciprocations are too rapid, and the internal disturbing forces are a maximum.

No one thinks that a goods engine with a tender is fit for the high speeds they are often run at of necessity, and their unfitness is just that of the tank engine; but it is not right to condemn all tank engines. Some are built with 5ft. 6in. wheels and a bogie, which run beautifully at as much as 60 miles an hour.

Some twenty-five years ago I had to do with the working of certain trains which had to be run from a large terminus to a junction, whence they were worked by express tender engines. Owing to reasons over which we had no control, one of these trains was worked every night for some time by a six-coupled saddle tank engine. The run was 3¾ miles; the time allowed five minutes, including starting and stopping; the load five coaches, say 80 tons; engine cylinders, 16in. by 24in.; wheels, 4ft. 8in. We never managed the run under six minutes, start to stop. The line was full of curves and points, but no accident happened, and the old engine ran very steadily. The speed got up to over 50 miles an hour.

I think that the whole question would be found well worth full discussion.

December 27th. CROXTED.

H.M.S. TERRIBLE.

SIR,—There is no "dockyard gossip" or "club gossip" in the matter such as "Superintendent Engineer" avers. I simply stated plain facts, viz., that the Terrible originally leaked in her steam pipe joints, and that she does not do so now. "Superintendent Engineer" is rather putting up men of straw of his own creation for his own knocking down. If he will refer to my first letters he will find that I mentioned the leaky steam pipes as one cause of a coal consumption—the 1902 one—which he well knows was abnormal. The average Belleville consumption is known to be well under 2 lb. per indicated horse-power per hour. In the recent trip the ship did this, and did it well—a matter of credit to her engine-room staff. In the 1902 trip she had an abnormal consumption. "Superintendent Engineer," if previous correspondence of his is any criterion, would, I suppose, like to saddle the blame on the naval engineers, coupling it with a theory of his own about economical speed. I say "theory of his own," because no uniform speed was observed in either trip. There were 15 knots, for instance, across the Indian Ocean in the recent trip.

Now, I, being more interested in facts than theories, attribute the bad performance of 1902 to two main causes. In the first place, there was great leakage of steam pipes in the joints; in the second place, the engine-room staff were not perhaps above reproach, since the ship came home with her casings very dirty, due probably to the steam-pipe worry occupying all attention. I imagine that the absence of these two defects, coupled with more careful stoking, easily and reasonably accounts for the great improvement of 1904 over 1902.

Before describing the leaky steam pipe hypothesis as "beneath contempt," "Superintendent Engineer" might have made a few inquiries. Anyone almost at the Clydebank yard could tell him that the principal items in the boiler refit of the Terrible were a very thorough cleaning and a great overhaul of steam pipes, making good weak joints.

I regret my inability to inform "Tiffy" as to whether any steam pipes were replaced during refit. I think it was merely a case of making the joints good and sound. As to why steam pipes only calculated to stand 150 lb. or so were employed in view of Admiralty conservatism, and the fact that the Belleville was a little known article when the Terrible was designed, there is nothing wonderful in it. At the first, I believe, it was contemplated to give the Terrible cylindrical boilers, and it is possible that when Bellevilles were decided on instead, steam pipes already made for cylindricals were worked in—anyhow the fact remains that her people had to do their best with defective steam pipes.

It is, I think, a great pity that when any of H.M. ships has done particularly well, there should be people anxious to prove that no credit is due to the engine-room staff. Taking them all round there is not a finer or more efficient body of men than our naval engineers and engine-room artificers, and it is regrettable that, with some of your correspondents at any rate, the main objective seems to be to have a sling at them at all costs. I am not a naval engineer myself, but an impartial observer. NAVALIS.

December 26th.

A THERMODYNAMIC PROBLEM.

SIR,—We are taught by modern philosophers to consider all matter as possessing essentially the same physical properties, only in different degrees. Thus, we are told that if pitch and steel be subjected to physical tests, results similar, but varying in degree, will be obtained. Or we may substitute lead for water or oil in a hydraulic press, and any one gas for any other gas in pneumatic appliances. A pure metal, such as mercury, we are taught to believe, is only a condensed and frozen gas, and the same fact is demonstrated with regard to hydrogen or nitrogen when we obtain substances which we know ordinarily as gases in solid metallic conditions.

Now, if we accept, as we must, this broad view of things, we must concede that every substance may conserve certain, at any rate, of its physical properties under changed conditions. For example, we know that if we expend work on gaseous hydrogen in compressing it its temperature will be raised, and it is fair to assume that if we could compress solid hydrogen, or do work on it by hammering or bending, its temperature would also be raised. We have an exact parallel in water and ice. By agitating water we may impart heat to it; by pressing upon ice we can cause it to melt.

This similarity between different substances and the same substance under different conditions suggests the following question. If we took the gases of which steel is made and compressed them, we should raise their temperature; and if we deprived them of the added heat at an appropriate moment and then allowed them to expand, doing work, we could keep lowering their temperature until they returned to the solid form—that is, to the original steel. Suppose, now, that the process was continued from this point; suppose that by bending or compressing or hammering we continued to raise the temperature of the steel by working upon it and robbing it of its heat by some external means, what would happen? It would seem logical to conclude that the temperature should continue to fall in the same manner as in the gases, at any rate as long as the elastic limit of the steel was not passed—that is to say, as long as it was able to expand after treatment approximately to its original bulk. I have assumed, probably quite wrongly, that solid steel could be condensed out of its constituents; but I do not think the problem is thereby affected. It is easier to think of steel than of such a metal as solid hydrogen, which could probably be produced—theoretically—in the manner indicated. J. J.

December 27th.

STANDARDISED WATER FITTINGS.

SIR,—The communications which have appeared in the daily Press on the standardisation of water fittings will have caused some surprise among those experienced in waterworks engineering, as it implies that this question is a new one, whereas in reality the solution of the question is already an accomplished fact.

The correspondents appear to be unaware that the Metropolitan Water Board in their New River Department have a complete standard for all fittings, the result of the most accurate scientific study and many years of experience. They have a testing department some 400ft. long by 60ft. wide, two storeys high, fitted up with all the most modern apparatus for examination, gauging, and testing, and no fitting of any sort is allowed to be used until it has been taken to pieces, examined and gauged for interchangeability, quality and weight of every part, and then subjected to efficient hydraulic test.

The standard of this department of the Metropolitan Water Board is so well known to water supply authorities that it is not only adopted by provincial waterworks, but accepted in all parts of the world as a trustworthy authority.

As the water supply connections used throughout the country are practically identical, there is no reason why this well-known London standard should not be used in Sheffield, Leeds, Glasgow, Edinburgh, or even Birmingham.

It is only fair to this great metropolis that it should be known that its own Water Board already possesses a most perfect and complete standard of water fittings suitable for all purposes.

December 23rd. LONDONER.

CHEAP STEAM PRODUCTION.

SIR,—We notice a letter from Mr. C. D. Leng giving the cost of evaporation per thousand gallons as just under 2s. 4d., and asking if this result can be beaten. We enclose result of some boiler tests made at the works of the Butterley Iron Company, Limited, Codnor Park, where you will see that this result is considerably beaten, the cost of fuel to evaporate each 1000 gallons of water being only 8½d. The cost of fuel even by hand firing was 2s. 3¾d., and the boilers, before the stokers and compressed air furnaces were fitted, were not doing, with the low grade of fuel used, their rated capacity. The company has been enabled to shut down several of its boilers in their works, and has fitted up the range of boilers at Codnor Park, and also at the Kirkby Colliery, with this machine and coal and ash elevating and conveying plant. We could give you plenty of other illustrations of low cost per 1000 gallons where cheap fuel is available.

We enclose you our latest catalogue "Cheap Steam," which has a curious resemblance to Mr. Leng's heading. The Stirling boilers fitted with Bennis stokers and hot air induced draught, at the Neepsend Generating Station, Sheffield, are doing over 80 per cent. efficiency, and using a very low grade coal.

Mr. Leng does not give us capital outlay and boilers required to evaporate his water, but this should be taken into consideration also.

ED. BENNIS AND CO., LIMITED.
Little Hulton, Bolton, December 26th.

SIR,—We have read the letter from Mr. Leng in your last week's issue, in which he asks whether the cost of 2s. 4d. for evaporating 1000 gallons of water can be beaten. In reply we send you particulars of a test carried out at Messrs. James Oakes and Co., Riddings Collieries, near Alfreton, on April 19th this year, the plant consisting of a Lancashire boiler, fitted with two patent hot air furnaces supplied by the Hot Air Furnace Company, of Birmingham—whom we represent—and one of our downtake superheaters:—

1.	Size of boiler	8ft diameter by 30ft. long
2.	Average boiler pressure	80 lb.
3.	Temperature of saturated steam	334 deg. Fah.
4.	Temperature of superheated steam	540 deg. Fah.
5.	Degrees of superheat	216 deg. Fah.
6.	Temperature of feed-water entering economiser	90 deg. Fah.
7.	Temperature of feed-water entering boiler	250 deg. Fah.
8.	Temperature of gases entering economiser	540 deg. Fah.
9.	Temperature of gases entering chimney	290 deg. Fah.
10.	Lb. of water evaporated per hour (actual)	9768 lb.
11.	Lb. of water evaporated and superheated per lb. of coal (actual)	9·5 lb.
12.	Equivalent evaporation of saturated steam from and at 212 deg., lb. of water per lb. of coal	12·2 lb
13.	Class of fuel	Dirty slack
14.	Cost of fuel per ton at colliery	2s.
15.	Actual cost of fuel to generate and to add 216 deg. Fah. of superheat to 1000 lb. of steam	1¼d.
16.	Equivalent cost of fuel to generate 1000 lb. of steam from and at 212 deg.	¾d.

You will see from the above that the actual cost of fuel to generate the steam from 1000 gallons of water, and superheating it by 216 deg. Fah., works out at 11¼d., as compared with 1s. 11d. for the generating of the steam alone in the case of Mr. Long's boiler.

Broad Sanctuary-chambers, EASTON AND ANDERSON.
20, Tothill-street,
Westminster, London, S.W.
December 28th.

THE NICLAUSSE BOILER.

SIR,—In THE ENGINEER for the 20th inst., amongst "Dockyard Notes," the Pennsylvania is credited with Babcock and Wilcox boilers, and, on the strength of this belief, the writer of "Dockyard Notes," who has always been just to Niclausse boilers, comes to the conclusion that between Niclausse and Babcock and Wilcox boilers in the United States navy "honours are easy." It so happens that the Pennsylvania has Niclausse boilers (a similar mistake was made some time back); and, so far from honours being easy, the Niclausse boilers "have it" on every point—steam formed per square foot of heating surface, and per pound of coal, &c.

Of the ships cited in your "Dockyard Notes" the Virginia only has Babcock and Wilcox boilers. H. P.

Greenwich, December 27th.

CHRISTMAS ENTERTAINMENT.—On Christmas Eve Mr. Jardine, of Nottingham, together with Mrs. Jardine, entertained in the Meadows Hall over 1300 of the children of the workpeople employed in Mr. Jardine's various factories. An excellent programme was arranged, many of the items, such as songs, dances and recitations, being contributed by children of the workpeople. The cinematograph, which showed a large number of instructive and amusing living pictures, was especially appreciated. Mr. and Mrs. Jardine addressed the children, and then presented each child with a bun, an orange, a Christmas card, and a piece of gold or silver money fresh from the mint, the amount given varying from 3d. to 25s., according to the number of entertainments attended. This is the twenty-first year in succession in which Mr. and Mrs. Jardine have entertained their workpeople's children.

THE PANAMA CANAL.—Engineers desiring positions on the Panama Canal should take notice that Civil Service examinations will be held in all the large cities of the United States on January 18th, of candidates for positions as assistant civil engineers, instrumentmen, transitmen, levelmen, rodmen, chainmen, and helpers. Free transportation to and from the Isthmus, medical attendance and quarters will be provided, while the commissary arrangements must be made by the men. Six weeks' leave at full pay will be given each year and special transportation rates between New York or New Orleans and Colon can be obtained. The salaries paid will be about the same as those on similar work in the United States, being 200 dols. to 250 dols. per month for assistant civil engineers, 175 dols. for instrumentmen, 150 dols. for transitmen, and 100 dols. to 125 dols. for levelmen. Applications for permission to take the examination, as well as for further details concerning the subjects, should be sent at once to the United States Civil Service Commission, Washington, or to the Secretary of the Local Board of Examiners at the Custom House or Post-office in any large city.

TRIAL TRIP OF THE MARYLAND, UNITED STATES NAVY.—Arrangements are in progress for the official speed trial of another great armoured cruiser, the Maryland, sister ship of the West Virginia, Colorado, and Pennsylvania, which probably will be held early in February over the course from Cape Ann to Cape Porpoise. She was built by the Newport News Shipbuilding and Drydock Company, of Newport News, Va. In connection with the trial of the Maryland, engineer officers especially, and naval officers generally, are watching with interest the showing that will be made by the ship's boilers. Two types of boilers now predominate in our modern ships of war, Niclausse and Babcock and Wilcox, and there has long existed a difference of opinion regarding the relative values of these types. The Maine, now undergoing repairs at the Charlestown Navy Yard, was the first ship of large size to be equipped with Niclausse boilers, and the West Virginia contains the first large installation of Babcock and Wilcox, although this type has been used in several small ships. In view of the close competition between the manufacturers of the boilers, naval officers have watched with interest the results of the tests. The armoured cruisers Colorado and Pennsylvania both have the Niclausse boilers. Records of the trials showed that the West Virginia used about 3 lb. of coal per horse-power per hour to attain a speed of 22·14 knots, whereas the Pennsylvania's record-breaking run of 22·43 knots was made with a coal consumption of only 2·20 lb. per hour. When it is considered that these ships each attained 28,000 horse-power, the difference in coal consumption is seen to be an important factor. On the trial of the Maryland, therefore, may hinge the adoption of one uniform type of boiler for our warships. —*Boston Evening Transcript.*

PRESS BUTTON ELECTRIC LIFT.

We recently had an opportunity of inspecting a new electric lift which has just been put into operation at Coventry House, Haymarket, by Messrs. Joseph Richmond and Co., Limited, of 30, Kirby-street, Hatton-garden, E.C. This lift is worked on what is known as the Richmond-Carey system—a system which has been in use for some eighteen months. The present lift, however, embodies some improvements not hitherto possessed by any lift of this type. Given quite diagrammatically, the suspension arrangements of this lift are as shown in the sketch, Fig. 1. Four suspension ropes are used, and these make just one half turn round the driving wheel, which is itself driven by a motor through worm gearing. There was some little trouble in fixing this lift, inasmuch as the space available was very small, and that a mosaic floor of the hall from which the lift starts could not be broken into. Everything, therefore, had to be arranged above the floor level, and yet it was necessary that the lift should not start at an inconvenient height above the floor. By the use of buffers and other ingenious means these difficulties were, however, overcome.

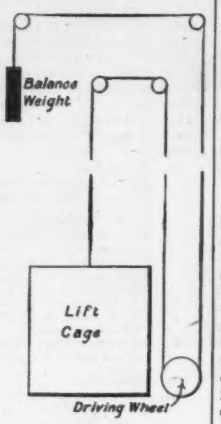


Fig. 1

It is the electric arrangements, however, to which we desire to direct our readers' attention. These will be readily understood by means of the following description and by the aid of the accompanying drawing, Fig. 2. This shows on the left-hand side the electrical connections in diagrammatic form. The positive main from the source of current is led to two solenoids, A and B. Should the solenoid A be energised then the outside connections are such that the lift will rise. If, on the other hand, current is sent round B then the lift is lowered. That is to say, A and B can operate the starting switch of the driving motor either in one direction or the other. These solenoids work with quite a small current—something less than an ampère, so we understand. The two solenoids are interlocked so that it is impossible for both to act at once. When current is going through neither, then the lift motor

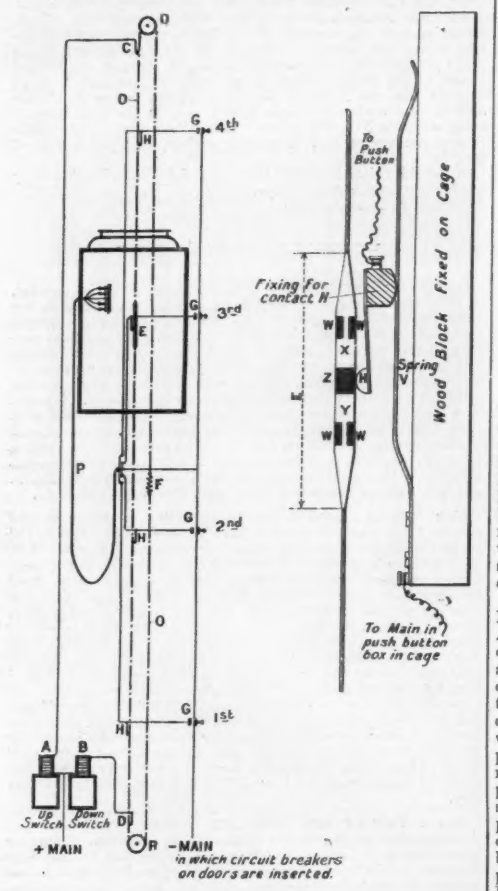


Fig 2

circuit is broken, an electro-magnetic break comes into use, and the lift is stopped. The other ends of the solenoids A and B are connected to rubbing contacts C and D, which are made to press up against a flexible copper wire O, which is run over insulated wheels Q and R. This conductor is kept tight by a spring F, and is connected to the cage by means of the insulating piece E. At the spring F there is a further insulated portion, so that the flexible wire O is actually in two portions, one going upwards from and the other going downwards from the cage and meeting at the insulating piece and spring F. Now, since this wire is connected to the insulating piece E, and hence to the cage, its movements must correspond to those of the cage, and *vice versâ*. G G G G are push buttons on each of the floors, and H H H H are flexible contacts fixed on each floor, which contacts press against the moving wire O.

If the connections of the diagram are studied it will be seen that if a push button on any landing above the lift be pressed, contact will be made from the negative main through the flexible wire above the lift, the contact C, and the solenoid A to the positive main. Thus the motor will be started and the lift will be raised to the floor required. When this point is reached, the contact piece will come over the insulating portion E, by which means the current in O, and hence in A, will be broken, the main driving circuit opened, and the lift stopped. In like manner, if a switch below the lift is pushed in, then contact is made between the negative main, the contact H, the portion of the wire O below the lift, the contact piece D, the solenoid B, and the positive main. This will start up the lift motor in a reverse direction, and the lift will descend.

It will be observed that there are a series of push buttons in the cage itself. Four of these correspond with, and do exactly the same things as, the switches on each floor, with which they are metallically connected through the flexible wire P. It may here be stated, though the actual connections are not shown on the drawing, that the negative main is connected with the push buttons on the landings and in the cage, only through switches on each of the doors on the landings and on the door of the cage itself, all these being in series. The cage, therefore, cannot be either raised or lowered unless all these doors are properly shut. Hence an accident through premature starting is a practical impossibility.

The counterweight of the lift is calculated out at the weight of the cage, plus half the maximum weight of passengers or load in the cage. It is obvious that the load need not always be constant, and this has the effect of stopping the lift at slightly different levels, because the speed and the time necessary for the mechanism to come to rest vary a little with the load. The difference only amounts to an inch or two, and may be disregarded altogether as far as ordinary passengers are concerned. If, however, it is a question of wheeling trucks, or perhaps the beds of patients in a hospital being taken from one floor to another, in and out of the cage, then any difference in level between the floor of the cage and the landing becomes of considerable importance. With the object of overcoming this an apparatus has been devised by Mr. Carey, of Messrs. Joseph Richmond and Co. This was being fitted to the lift we inspected, but was not actually in operation. It is known as the rectifier, and is simple in its action. It is shown to the right-hand side of the engraving in Fig. 2. Here E is the insulating piece fixed on the cage. It is, instead of being one solid piece of wood, made up partly of metal and partly of insulation; X and Y are conducting parts, and W, W, and Z are insulating portions. H is the contact piece, and V is a spring contact connected to the negative main fixed on the cage. As the car comes to a floor this spring makes connection between the negative main and H. When H passes W the current is broken, the main switch cuts off the current to the motor in the way already explained, and the lift is stopped. Should it stop at the floor line, H will be in the position shown, with the current broken by the insulating piece Z, and nothing further will happen. Should, however, the cage slightly overrun or stop short, then H will be in contact with X or Y, and as H is in contact with the negative main through V, the lift will be started again, and will go to the floor level. Before the cage has time to gain speed, H comes to Z, the current is broken, and the lift finally comes to rest.

An important part of the whole system is the push button. It is the invention of one of the firm's works managers—Mr. A. C. Burnett—and is shown in Fig. 3. It is a combination of an electric solenoid and a locking device, whereby, when any button is pressed, either on a landing or in the cage, every other button, in addition to that pressed, is locked, so that no other circuit can be closed. The appliance itself consists of a cast iron box, with a hollow centre core, upon which a solenoid B is fixed. Its action is as follows:—On pressing the button A the coil B is energised, producing a magnetic field, and the ring armature C, with the locking plate C^1, is attracted upwards behind the collar D on the spindle of the push button. All the solenoids of the various push buttons are in series, and the ring C is lifted in each case. It will be evident, therefore, that, until the current is broken by the cage arriving at the floor intended, the original push button cannot be pressed outwards by its spiral spring E, nor can any of the other buttons be pressed inwards by the hand. The only exception to this is that there is, in the cage, an emergency button which can be pressed, and the controlling circuit opened should the necessity arise. In this event the main circuit will be opened, the brake applied, and the lift stopped.

The advantages claimed for this form of press button lift are that it is very simple and complete in itself; that since the circuit-opening device is on the lift itself, and the contact piece at each floor, the cage must always stop approximately where required, and is independent of any stretching of the ropes; and that it can be fitted either to a drum-driven or friction-driven lift.

We may mention in conclusion that a simple arrangement of this gear, suitable for goods or service lifts, is also manufactured by this firm. In this the control, instead of being done by buttons, is carried out by means of a contact arm moved over a series of fixed contacts, one of which is connected to the contacts on the trolley wire for each floor. A rod or cord is passed down the well-hole, to which handles are attached, one to each floor. This actuates the movable contact. The operator, say, at the bottom, simply puts his handle pointing to the number of the floor desired—the floors being marked on a quadrant—and the lift automatically goes there. By this arrangement it is possible not only to call the lift to any floor, but when it is loaded to send it to any floor at will. The handles also form indicators, as the lift must follow the handle, so that if the handle points to the third floor the lift must be at the third floor, or be travelling to it.

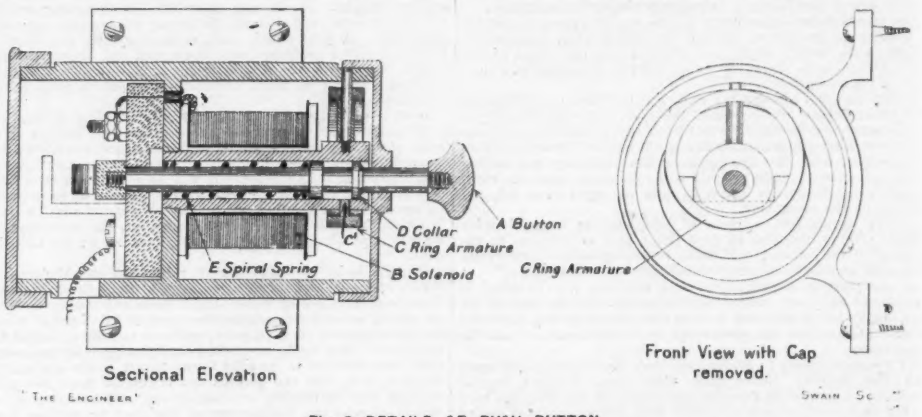


Fig. 3—DETAILS OF PUSH BUTTON

DOCKYARD NOTES.

Some notes from the Home Fleet—the "Channel Fleet," as it is now in process of becoming—may be of interest. The Swiftsure and Triumph, which were supposed to suffer from weak scantlings fore and aft, have not exhibited any serious defects in this direction. On firing the big guns end-on they depressed their decks slightly, but these decks immediately returned to nearly the original position, and elasticity of a high order in this direction is now credited to the ships.

At target practice they attracted particular attention owing to the sheets of flame which enveloped them when they fired their broadsides. Nothing, we hear, gave such an impression of their gun power as the sight of them firing. As sea boats they have proved better than was expected, and they are doing very well in the way of speed.

The Royal Sovereigns have all done conspicuously badly at coaling ship. They were never easy ships to coal, but since the new casemates have been fitted they have been considerably worse. Coal can be got aboard at a fair speed, but stowing fast is practically impossible.

The new Japanese cruiser Otawa is not, apparently, a sister to the Nüitaka. She is fitted for a 6in. gun fore and aft, and six 4·7's in the waist. She is also longer and narrower than the Nüitaka and Tsushima, and so, it is expected, will steam better than those two cruisers.

It has recently become known that the small Japanese cruiser Yayeyama was sunk some time during the war, but she has lately been raised and put into service again.

Some curiosity has been aroused in naval circles by the fact that Admiral Togo, in his report, attributes the loss of the Yoshino to mines, and not to collision with the Kasuga, as originally reported. Probably Yoshino is a misprint for Yoshima—that ship having been mined—or, more probably, torpedoed—at the time the Hatause was lost. She was towed to Sassebo, and sank twenty miles off that port.

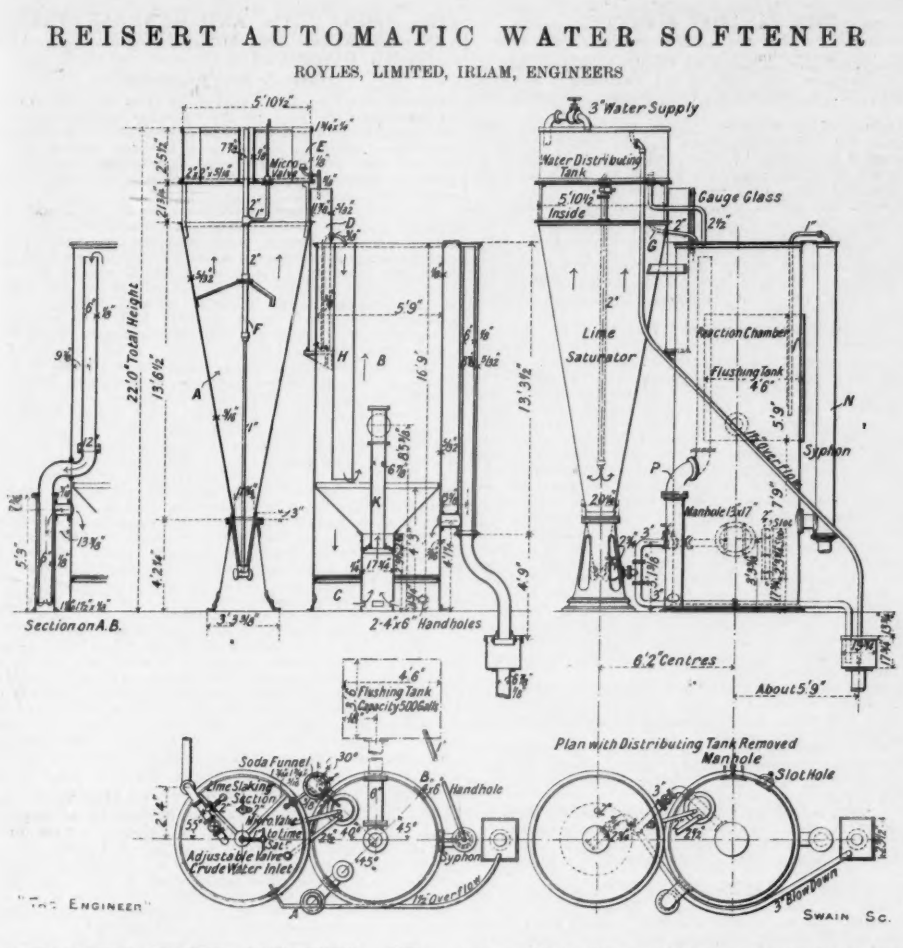
Next March the Cæsar will be commissioned as second flagship of the Channel—ex home—Fleet.

The cruiser Cumberland left Portsmouth on Wednesday to join the first Cruiser Squadron.

In an "interview" with M. Pelletan, a contemporary publishes the following question:—"And what, M. Pelletan, are your views on the *guerre de bourse?*" There is many a true word spoken in jest, also apparently by accident. The whole system of the *guerre de course* rests on attacking the enemy's pocket, but it has been left to a misprint or an interviewer's ignorance of technical terms to coin an expression worth ten of the original one.

M. Pelletan is apparently not enamoured of his new cruiser, whether the Edgard Quinet or "C 17" is not quite clear. Probably C 17, as he describes her as being somewhat in the Vittorio Emanuele style. We are by no means sure that he is correct, even if a Vittorio Emanuele cannot catch an Edgard Quinet or a Renan, it is very clear that neither cruiser would attempt to catch a Vittorio. Consequently where a Vittorio was, there would they take good care not to be. On the other hand, there is some force in his contention that a Vittorio Emanuele is neither battleship nor cruiser. She is excellent for a nation like Italy, but probably of little use to us, and if not to us, also not to France, as she still aspires to have a "grand navy."

The Institution of Civil Engineers: Yorkshire Students' Association.—The third ordinary meeting of the above Association was held in the Law Institute, Leeds, on December 15th, the president, Mr. Ewing Matheson, M.I.C.E., in the chair, when a paper was read by Mr. H. J. Rudgard, A.M.I.C.E., on "Notes on the Construction and Erection of Steelwork." Mr. Rudgard pointed out that the usual types of girders and roofs are now more or less standardised, and discussed the various points of construction by attention to which increased economy can be obtained. The use of rolled sections and avoidance of smithwork are means to that end. The author called attention to the necessity for thoroughly cleaning steel work before assembling and painting. Points arising in connection with erection were then gone into, and a description given of the renewal of a bridge which had to be undertaken on a busy line without interfering with the traffic. The various points were illustrated with diagrams. A long and interesting discussion followed, and a hearty vote of thanks was accorded Mr. Rudgard for his paper.



AUTOMATIC WATER SOFTENER AND PURIFIER.

WE give an illustration herewith of a water softening apparatus which is made by Messrs. Royles, Limited, Irlam, near Manchester, who have the sole right of manufacture in this country of this apparatus, which is known as the Reisert automatic water softener and purifier. This type of plant has found great favour on the Continent, there being, so we are informed, more than 2500 in use at the present time. There are several advantages claimed for this apparatus, but perhaps the most important is that it is entirely automatic in its action. There are no mechanical moving parts, and consequently the chances of failure are reduced to a minimum. Wherever this plant is laid down, a careful analysis of the water to be treated is made with a view to finding out the impurities which would be harmful for the purposes for which the water is wanted. These impurities are then destroyed by different reagents. By this means water for any purpose can be treated in a proper and efficient manner. The main principle on which the apparatus works depends upon the fact that carbonate of lime is precipitated by hydrate of lime —lime water—and sulphate of lime by soda. After this treatment, the water is filtered and discharged into storing tanks. There are five essential parts in the apparatus—the chamber A, in which the lime water is contained, a reaction chamber B, a cleansing filter C, a soda tank D, and placed on the top of the chamber A is a circular distributing tank E divided into three separate divisions, one for the water to be treated, one for slaking the lime, and the other for mixing the sodium carbonate solution. The action is simple. In the conical-shaped chamber a saturated solution of lime water is made. Water flowing from the distributing tank—situated at the top of A—through the micrometer valve M and down the pipe F, stirs up the lime paste at the bottom and carries it along until the tank widens sufficiently to prevent the undissolved particles from being able to follow the water, which becomes clearer the higher it gets up the chamber, whilst at the top it should be quite clear. The saturated solution then leaves the saturator through the pipe G at the top of the chamber. This pipe carries the solution to the reaction chamber through the mixing pipe H. Here the water comes into contact with the soda solution, and passes into the reaction chamber B. When this chamber is full, the water flows down the pipe P, and finally reaches the filter C. The filter and its manner of working forms the most interesting part of the apparatus. The bed consists of a layer of large stones varying in size from ¾in. to 1in., and on the top of this comes a layer of fine gravel, and above this a thin layer of river sand. After the water has passed through the filter it flows up the central pipe K and out into a flushing tank, and from there into the main receiving tank. The process is then completed. Particular attention is drawn to the manner in which the filter cleanses itself. The height of the column of water in the pipe P depends upon the resistance of the filter bed, and as soon as the resistance becomes sufficient to cause the water in the pipe N to overflow, it forms a syphon, and immediately reverses the current through the filter bed, thus drawing back the clear water from the flushing tank and cleansing the filter, all the sediment being discharged into a gulley or other suitable receptacle. The flushing tank is made large enough to allow of the thorough cleansing of the filter, and as soon as the tank is empty, water enters the pipe and destroys the syphon action, and the filter then resumes its normal action. It will thus be understood from the description that the whole working is entirely automatic. A few further details of the distributing tank may be interesting. The number of compartments the large tank is divided into depends upon the treatment the water is subjected to. Hydrate of lime dissolves in a definite amount of water, hence the water will not dissolve any more than this quantity, however much lime is there. Therefore it is possible to allow a certain flow of water to be supplied in a definite proportion with hydrate of lime for the precipitation of carbonate of lime. On this depends the purification of the water. Lime is placed in this division once a day, the quantity depending, of course, on requirements, the lime is slaked, and the paste obtained is conveyed in bulk through a short pipe to the bottom of the saturator, and from here the sludge can be removed. Soda is not like lime, there being practically no limit to its solubility, therefore the carbonate of soda can be dissolved at once in the soda chamber of the distributing tank. Water flows through the micrometer valve, which is adjusted to allow the correct amount of soda to pass through into the soda chamber, and, owing to the fact that soda solution has a greater specific gravity than water, the latter always remains on the top and displaces the solution, which passes through a small pipe into the mixing pipe, and finally into the reaction chamber.

THE POINT OF VIEW.*

By WALTER C. KERR.

IT is a pleasure to talk to a lot of young men who are about to become engineers. It was not so long ago that I came to your age less well-prepared, perhaps, than any of you. When I look back at the engineering education through which men of my time were launched, and then consider the training you have had and the opportunities before you, I have reason to wonder why I am here. I hesitate to advise you. You have already had so much advice that I do not know whether you can hold more. What I can say in a few minutes will amount to little, so let me use these minutes to suggest that you advise yourselves along certain lines which I will propose by way of point of view. If you look straight you will see straight. You cannot think wrong and act right. Your perspective will be distorted if you haven't the right point of view.

You are leaving a good institution for a good world. Your *Alma Mater* has built up around you excellent facilities for giving you what you need, and other institutions have likewise cared for their own. The so-called liberal education has always been highly academic. Trade school engineering has been strictly non-academic. The two have joined hands fortuitously in our modern institutions. The liberal education has become less and the technical more academic, with advantage to both. There is, however, danger of engineering education growing too academic, for several reasons: One is the disposition to include in technical training a liberal education, which of itself is not undesirable. Another is that engineering professors often lean unduly towards academic views and processes, and thus lose touch with the spirit of the engineering world. Greater than either of these is the tendency of all things to move in the line of least resistance, and all learning which depends upon the intellect alone is more easily acquired than that which depends upon other sources. The proof of this need go no further than to remember that no literature is finer than that written two thousand years ago; no philosophy has fundamentally improved upon that of the ancients; the highest flights of intellect and mathematics were reached during the ages in which the world was observed to be composed of four elements —earth, air, fire, and water.

A review of knowledge shows the great preponderance of the intellectual over the material, and it is only within late centuries, in fact almost the past century, that the human mind has seemed capable of turning from the lesser resistance of intellectual attainment to the greater capacity for physical observation and comprehension. We have but recently come to the era of intense mental operations, dealing with laws and principles which require insight greater than the intellect can grasp unless aided by the senses. Contrary, therefore, to common belief, I assert that the highest refinement of knowledge follows from the highest use of the senses; and that it has taken thousands of years of pure intellectual development to attain a state in which the powers of nature can, through the human intellect, be made useful to mankind, and add largely to knowledge. Do not, therefore, get a wrong view of the faculties involved in science, in the application of the laws of nature, applied mechanics, and the powers of comprehension which underlie engineering. There is still room for doubt—not debatable here—as to what constitutes liberal education.

I hope for the time when the spirit of engineering as found in practice will form a more definite part of engineering education. This, I think, must come through the professor keeping in close practical touch with the engineering world. There are various ways in which this may be accomplished, but I know of none better than by each professor doing a reasonable amount of practical work for commercial purposes. Under some conditions this may be consistently accomplished during a portion of his time, but I am inclined to think that eventually our professors will devote all their time to instruction while they teach and go periodically into the world, a few years at a time, for practice. Thus the professorial life would not be so exclusively educational, and our growing engineering institutions may be enabled to enlarge their faculties by the devotion to teaching of a portion of the time of men who are primarily engaged in commercial work.

Now that you have your so-called education, what are you going to do with it? I cannot tell you, but I can suggest some points of view.

Begin by forgetting yourself. All thought of self is some form of selfishness, and selfishness never produced anything better than more selfishness. It often breeds something worse. Genius is all right in its way, but it will not do your work. Get a right idea of work. Remember that time is the essence of most things, and is not inconsistent with thoroughness.

We hear much about opportunities. They are everywhere plentiful. Remember that your opportunity is the little one that lies squarely in front of you, not the large one which you hope to find further along. Many a man is surrounded with opportunities who never seizes one. There are traditions that Adam, William Tell, and Sir Isaac Newton each had an affair with an apple, but with different results.

Your first duty is always to that which lies across your path. The only step which you can take in advance is the next one. This leads to a simplicity of action which is commendable. Don't ramble.

The refinement of thought which is apt to follow high training often leads the mind to overlook simplicity and to even seek complexity. The wealth of modern appliances tends likewise; and it is thus easy to acquire that over-refinement, often termed theoretical, as against the simplicity which is called practical.

From one point of view, all graduates can be divided into two classes—those who think their knowledge is a little long for their opportunities; and those who think most anything is a little long for their knowledge. Both are apt to think that the knowledge they have acquired will become the essence of performance. You will soon find that knowledge hasn't much to do with effectiveness. It is necessary only as words are essential to the expression of thought. You will find knowledge a good tool, but not the vital force with which you perform. You will fall back upon human effort and action, and find that it is the human engine and not the knowledge-engine that does the work.

Cultivate singleness of purpose. This is more important than you may think. It is intuitive with the comparatively ignorant, and often absent in the highly trained. We are frequently surprised at the great competency of the ignorant contractor or foreman, on whom judgment is often passed by saying that he is a practical man and gets results. Analysis will show that his best quality is singleness of purpose, which leads him to vigorously do the one thing before him, without distraction following from knowing or thinking about too many other things. The broadening power of education and training increases the range of contemplation, but unless the power of concentration is cultivated there follows a tendency to scatter instead of to acquire that singleness of purpose which leads to effective action. David Starr Jordan has said, "The purpose of knowledge is action. But to refuse action is to secure time for the acquisition of more knowledge. It is written in the very structure of the brain that each impression of the senses must bring with it the impulse to act. To resist this impulse is to destroy it. . . . This lack of balance between knowledge and achievement is the main element in a form of ineffectiveness which, with various others, has been uncritically called degeneration." Thus President Jordan shows how even much more than a little knowledge may be a dangerous thing. The highly-trained man therefore needs, as a complement to his training, unusual powers of concentration, in order that the virtue of singleness of purpose may not be lost. This faculty a man must have or acquire himself. It is not in the books. It cannot be taught. It can only be suggested by precept and example.

From directness of purpose naturally follows diligence in getting what you go after, and not being easily turned aside by resistance. When you are getting what you go after, get it all. Avoid the mediocrity of compromise. Be thorough and stand for full competency in everything, from main essentials to details. Just so far as education, assisted by concentration, contributes to singleness of purpose, it is useful, but where by length, breadth or depth it dilutes human effort, it lacks value. It is, therefore, not so much the question how much educational training you have as it is how you use it. Some can use a little with great effect, because their point of view is right; others scatter so badly that they cannot use their knowledge at all; while some distorted minds seem to have a faculty for misapplying a large amount of acquired knowledge through complicated processes full of error. To be right, you must be 100 per cent. right. Charity may pardon human nature its percentage of delinquency, but this is a human matter. The laws of nature, mathematics, and engineering do not pardon anything. The man may therefore be absolved from censure, but his work must stand the rigid test of inviolable law. Nor is it too much to say that you must be right the first time. Much of our engineering is only done once, and it must be done right that once. A man who has learned by experience to do a thing deserves no credit for doing it right. He is then only a repeating machine. Real power is characterised by ability to perform right the first time that which a man never did before. Such performance involves the power to assimilate and adapt experiences, of more or less like or unlike kind, in a way to bring forth correct results. This is the true use of experience, wherein a man is a thinking, active power, and not a mere repeater.

Clearness of thought is an essential often lacking. This, too, follows from concentration and singleness of purpose. Many minds confuse themselves with a wealth of ideas, grading from the well-formed to hazy, indistinct conceptions. You can clear your mind by proper habits of thought. Train yourself to separate essentials and non-essentials, and confine your consideration to the essentials; to distinguish between what you know and what you only vaguely surmise, clearly eliminating opinion from facts. Nothing is more helpful than conference with yourself, in which you determine what you think of your own thoughts. This is aided by the moderate cultivation of system—thinking in an orderly manner, beginning at the beginning, ending at the end, and being sure to have a middle. With this there should be no slavery to system, but let each find his own logical way.

Besides what are commonly known as ideas, men have intuitions —sometimes called impressions or opinions—which they cannot readily prove. These, I believe, are identical with reason, except that while reason is composed of a sequence of distinct ideas, each capable of expression, intuitions follow from the capacity of the human mind to integrate small ideas and impressions, each of which is too small to stand alone, or to be readily expressed, but which integrated form a concrete mental impression, called an intuition, and which is of exactly the same character as reason, except that it is composed of smaller and almost intangible units. Do not, therefore, discard intuitions as inferior to reason. Analysis will sometimes develop intuition into an expressible logical thought.

You have all had ideas and you will have more of them. Some ideas seem bigger than others. These mental forces, like other

* An address delivered to the Graduating Class of the Stevens Institute of Technology, on Thursday, June 16th, 1904.

forces, only do work when in motion. Hence, your ideas are only valuable when put into execution, and this often requires more talent than to originate them. Some men seem to consider their ideas so good that they will execute themselves.

A point of view is involved in the power to rationalise. This again is a thing which each man does for himself in his own best way, and its essence consists in asking one's self whether the thing is reasonable. It is a great check upon error It applies equally to nearly everything of which engineering is composed. It is the power of the human mind, after performing in more or less systematic and conventional ways, to stand off and look at results and ask one's self whether they are reasonable. One man will figure that certain material weighs 200 tons, and believe it. Another will say that there is something wrong in that, for it all came on two cars.

Every young man comes sooner or later upon a dilemma, in which he is more or less drawn in opposite directions by his confidence on the one hand and timidity on the other; a desire to perform backed by the courage of his convictions, but on the other hand resisted by his inability to see his way through in orderly progression, to a desired end. This is about the time to show your nerve. Do not be dazed and baffled, but make a start. Use your wits and you will get somewhere, and if you cannot always see the end it will constantly get nearer and plainer when you go as far as you can see and then see how far you can go.

Another point of view concerns engineering expression. This may be through designs, drawings, mathematical determinations, or words, and finally by work done. The lamest of these is words. All engineering is so non-literary in character that the use of language is too much neglected, leading to expressions that do not properly convey thought. In engineering, it is not rhetoric but diction that makes expression clear, and diction is best learned from the dictionary. It is well for a young engineer to cultivate his vocabulary, and learn to use words in their right sense. They are then usually understood, even by those who have less knowledge. A word of caution, however, against assuming that a lack of facility of expression can cloak an absence of knowing what you think. Engineering documents, specifications and letters are full of misstatements due to the careless use of language. Conciseness cannot be over-estimated. Brevity is desirable, but not at the expense of clearness. Conversely, a certain degree of facility should be acquired in reading the words of others. Some seem incapable of understanding plain language when spoken or written. Anyone persistently failing to understand the language of others has limitations needing correction.

One of the worst attributes in engineering, and which is fundamentally born of conceit, tends to fasten error, censure, and responsibility on others. There are times when a man needs to stand himself up in front of himself and ask, What is the matter with me? The capacity of any man to admit his own error and frailty of judgment is a measure of strength rather than weakness.

Perhaps no personal attributes are of greater importance in the conduct of the business affairs of an engineering life than good cheer and non-contentiousness. Not only because these are right and agreeable, but because they enable a man to work better, to be better understood, and they add weight to his opinions. There is a certain reasonable optimism of manner which makes a man and his ideas welcome, even though they must of necessity sometimes be critical. To vote aye and believe that things can be done makes a man helpful to others and to enterprises. Discontent is not a sign of progression.

Each of you probably has a preconceived notion of following some line of engineering. Be careful about your self-analysis. The field is large and has room for all of the various types of men, some of whom incline to constructive operations, others toward inventive, some to the contemplative. Again, within all these divisions, some tend towards professional and others trade work. No one can advise what is best for you. This you must find out for yourself. I cannot help, however, a certain predilection in favour of a young man being just an engineer, and not any particular kind of an engineer—not specialising while too young, but developing along versatile lines, ready to turn his hand equally well to any task within his general scope. In this, there is a good deal in the point of view, and the man who believes he can apply himself in one direction about as well as another will come nearer doing it than one who thinks he cannot.

When you start your practical work you will doubtless try to improve things. That is a legitimate purpose, if not overworked. I am not going to attempt to tell you what needs improvement, but the one improvement that most things need is in the line of sufficiency. You can think this over for yourself and apply it where it fits.

There is another point of view seldom considered. It relates to environment and the power to vary. It is pertinent to engineering. Man ascended through and exists under the laws of an organic evolution, which occurred almost entirely in early geological ages, under water, within a few miles of shore, under substantially constant temperature, constant pressure, and uniform food supply, and thus in about the simplest possible environment. It was caused, primarily, through the force known as the power to vary, and the reason that evolution spanned the space from the simple cell to the vertebrate animal in so short a time was that this power was not resisted by complex environment. When organisms emerged from the water to the more complex environment of the land, and as environment grew constantly more intricate, its resistance retarded evolution and resulted in fixation of species until ordinal evolution practically ceased. It is the complexity of the environment of the world that presses upon you and tries to hold you back from the exercise of your native power to vary. A good environment is certainly less harmfully resistant than a bad one, but remember that environment is not a force. It is not a producer. You are the producer. Whatever be your power to vary, environment will only resist and reduce it.

Therefore, remember that all the good you accomplish is going to come out of yourself. You cannot borrow it and you cannot make it out of that which has been poured into you by education or otherwise. All that you receive is only a certain quantity of knowledge, acquired by education, experience, or other training, which will have a certain influence upon what comes out of yourself as your own. It is the inherent capacity to perform with your own brain which will make you what you become, and not the mere transmission of that which you have acquired. Your knowledge, therefore, is of little avail until you make it inherently a part of yourself through mental assimilation and utilisation. The clearer you comprehend these things, the more readily you can make use of them as against the process of mere acquirement with a vague motive that in some way or other what you acquire may be of benefit, or that environment will be the force that makes your talent effective. Some have gone through experience without acquiring it, and many a man who has received an education has not got any because he allowed it to be a thing apart from his personality and it slipped away.

ALMANACS, DIARIES, &c.

FROM the British Electric Transformer Company, Limited, Hayes, Middlesex, we have again received an elegantly bound copy of the 1905 Whitaker. It contains a few excellent illustrations of the company's products. Messrs. Geipel and Lange have sent us a small pocket diary in which some useful engineering tables are included. The wall calendar which the firm of W. T. Glover and Co., Limited, has issued, is of the block variety with daily slips. The special feature of this publication is the reproductions of photographs of electrical engineers bearing the dates of their births.

THE FARADAY SOCIETY.

THE tenth ordinary meeting of the Faraday Society was held on Monday, December 19th, 1904, at the Institution of Electrical Engineers, Mr. J. Swinburne, Vice-president, occupying the chair.

The minutes of the November meeting having been confirmed and signed, the Chairman announced that the Council had made the following nominations of officers and members of Council to serve during the coming year. The election will take place at the annual general meeting, to be held in February.

President: Lord Kelvin, O.M. Vice-presidents: Professor A. Crum Brown, F.R.S., Sir W. Huggins, P.R.S., Sir Oliver Lodge, F.R.S., Dr. Ludwig Mond, F.R.S., Lord Rayleigh, O.M., Alex. Siemens, Pres. I.E.E., James Swinburne. Council: G. T. Beilby, Bertram Blount, W. R. Cooper, Sherard Cowper-Coles, Professor A. K. Huntington, Dr. R. A. Lehfeldt, W. Murray Morrison, Dr. W. S. Squire, Dr. O. J. Steinhart, Professor E. Wilson. Treasurer: Dr. F. Mollwo Perkin.

M. Adolphe Minet communicated Part II. of his paper on "The Electric Furnace: its Origin, Transformation, and Applications," which was read in abstract by Mr. R. S. Hutton. In the first and introductory part of his paper, which was read before the Society on June 9th last, M. Minet showed that the historical development of the electric furnace falls into the three following periods:—(1) Laboratory furnaces, 1808 to 1886; (2) industrial furnaces, 1886 to 1890; (3) development of industrial applications from 1890 to the present day. The present instalment, after some preliminary general remarks on the electro-motive force, current densities, and yields, with arc furnaces and resistance furnaces respectively, proceeds to deal in detail with the evolution of the furnace during the first period. The subject is subdivided as follows:—(*a*) Original furnaces, namely, Davy's arc, Pepys' resistance furnace for the cementation of iron, and Davy's and Napier's cathode furnace; (*b*) Electrolysis at high temperatures: the production of aluminium and its alloys, and the alkali and alkaline earth metals; (*c*) Miscellaneous furnaces, of which the most important are the early Despretz and Pichon furnaces, Berthelot's electric "egg" for the synthesis of acetylene, Siemens' and Huntington's well-known steel and other furnaces, the Louis Clerc furnace, interesting as the progenitor of the famous Moissan type, and Borchers' resistance furnace.

The paper, which is illustrated with diagrams of the principal furnaces alluded to in the text, closes with a bibliography covering the period dealt with. A final instalment will discuss the furnaces of the second and third periods.

Mr. W. B. Clarke referred to the importance and difficulty of making temperature determinations of electric furnace processes, and expressed the hope that M. Minet would deal with that question in Part III. of his paper.

Mr. L. Gasta handed round some "siloxicon"—one of the newest products of the electric furnace—and described its properties.

Mr. E. Kilburn Scott—communicated—described some of his experiences in the early days of the manufacture of calcium carbide.

The Chairman described a novel type of furnace that he had once hit upon by accident, and which he thought might turn out to be useful. He was sending a current through fused barium chloride, and the temperature having been allowed to get too high the cast iron crucible melted and formed a fused mass that was kept together by an outer skin of solidified chloride. This suggested the use of a neutral substance like barium chloride for heating to a very high temperature alloys or metals which it was desired not to contaminate with impurities.

Dr. F. Mollwo Perkin read a paper by himself and Mr. W. C. Prebble on the "Electrolytic Analysis of Cobalt and Nickel."

Mr. F. Gelstharp presented two short papers entitled "The Electrolytic Preparation of Tin Paste," and "Note on the Electrolytic Recovery of Tin" respectively, which were read by the secretary.

CATALOGUES.

MIRRLEES WATSON COMPANY, Limited, Glasgow.—This leaflet describes a jet condensing plant in use at the works of the Scottish Co-operative Wholesale Society, Limited, Glasgow, and is capable of dealing with 48,000 lb. of exhaust steam per hour.

STEWART AND LLOYDS, Limited, 41, Oswald-street, Glasgow.—This is a stiff cloth bound pamphlet, containing notes on Stewart's standard flanges, welded solid on pipes. This has proved a highly satisfactory method of providing flanges on iron and steel pipes.

PHŒNIX FOUNDRY COMPANY, Limited, Derby.—This catalogue contains particulars of the various kinds of engineering work for which this old-established firm has become prominent. Illustrations are given of railways, bridges, buildings, and constructional engineering details.

ERITH'S ENGINEERING COMPANY, 70, Gracechurch-street, London.—A pamphlet on "Smoke Prevention Effected by Economical Combustion," serves to introduce this firm's system of underfeed stokers. The book contains considerable useful information on the important subject of complete combustion of coal.

JOSEPH RICHMOND AND CO., Limited, 30, Kirby-street, Hatton Garden, E.C.—This is a portfolio containing large sized illustrations of lifts and cranes of all varieties. Electric passenger and goods lifts, hydraulic lifts and cranes, and manual and power-driven lifts are all illustrated and indexed in their various sections.

FAIRBANKS COMPANY, 78-80, City-road, E.C.—Catalogue No. 130 is given up to Yale and Towne chain blocks of three types, viz., differential, for occasional use; duplex, for general use; and triplex, for constant use and economy. One interesting illustration shows a large electric motor being quickly raised by a 16-ton triplex block by four men.

CLAYTON AIR COMPRESSOR WORKS, 114-118, Liberty-street, New York, U.S.A.—A 48-page pamphlet has been issued by this firm, which is devoted to air compressors and vacuum pumps. Over twenty types of machines are shown, including single and duplex, steam-driven, belt-driven, and electrically-operated machines. The air lift is also illustrated and described.

HORACE P. MARSHALL AND CO., Leeds.—Catalogue of foundry machines of many kinds. The up-to-date modern foundry must contain a number of labour-saving appliances, such as pneumatic hammers, and sand-rammers, core-making machines, &c., which only a few years ago were never heard of. This little book gives particulars of many well-tried machines of this kind.

JOHN I. THORNYCROFT AND CO., Limited, Chiswick, Southampton, and Basingstoke.—This is one of the most effectively-produced catalogues which has come under our notice for some time. It deals exclusively with steam wagons, of which the several types hitherto produced at Basingstoke are well illustrated. The book also contains illustrations of the works themselves, which our readers are acquainted with.

UNION ELECTRIC COMPANY, Limited, 151, Queen Victoria-street, London, E.C.—Enclosed arc lamps of the "EV" and "EVS" type are dealt with in this leaflet. The "EV" lamps are made both single and double enclosed, and of two burning hours, viz., 100 hours and 300 hours. In each case the remains of the positive carbons are used up when trimming as the negative carbons. With the 300-hour type a special arrangement has been introduced, securing a minimum consumption of carbons, and ensuring practically no deposit on the inner globes. The "EVS" type lamp is specially constructed for burning in long series.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

THE works have been laid off most of this week, and in many cases for the whole of the week, for the Christmas holidays, and with the exception of stocktaking and repairs little or nothing has been done. After the welcome rest, however, business will be resumed, and there is every reason to anticipate a satisfactory period, as there is a good number of orders on the books, and the general tone is hopeful.

The year 1904 has been a quiet period for the engineering and iron and coal trades of this district. It has constituted the latter part of a trade depression, which has lasted three or four years, but the closing months have seen considerable improvement, and there are indications that a trade revival has set in. The news of great activity in the United States has helped the improvement in the Midlands latterly, although over-production out there would probably lead to a recurrence of the inevitable "dumping." Staffordshire cinder forge pig iron, which opened the year at 47s. 6d., closes it at 42s., or a decline of 5s. 6d.; part mine has declined during the twelve months from 49s. 6d. to 46s., or a drop of 3s. 6d.; all mine ordinary, which was then 60s. to 65s., is now 55s. to 60s., or a drop of 5s.; but best is still 75s. to 80s., or the same as then; and cold blast is still unchanged at 95s. to 100s. Northamptons, which were 45s. 6d. to 47s 6d., are now 42s. to 43s., or a drop of between 3s. 6d. to 4s. 6d.; Derbyshires, which were 47s. 6d. to 48s. 6d., are now 44s. to 45s., or a decline of 3s. 6d.; whilst Lincolns, which were 50s. 1d, are now 51s. 7d., or a rise of 1s. 6d.—being the only class of pig iron in which quotations are higher now than when the year opened.

In the manufactured iron trade the demand for galvanised corrugated sheets has been good throughout the twelve months from South America, India, and Australia, and this has made up for a falling off in the continental and South African trade. The quotation for galvanised corrugated sheets of 24 gauge, f.o.b. Liverpool, when 1904 opened was £10 10s. to £10 15s, and at the close of the year they are being quoted at the same figures. Prior to November 10th they had been quoted for some time at £10 5s. to £10 10s., but on that date another 5s. was put on in consequence of the continued advance in spelter. Marked bars opened the year at £8 10s., but on January 14th 10s. was taken off, leaving them at £8, at which they have remained ever since. Common unmarked bars, which opened the year at £6 to £6 5s., are being quoted as 1904 closes at 5s. under those figures. The recent decision to maintain the Midland Iron and Steel Wages Board has been one of the chief events in the year in the manufactured iron trade so far as the relations between employers and employed are concerned.

In the steel trade most descriptions are being quoted the same at the present time as they were when the year opened, namely:—Bessemer billets, £4 5s. to £4 7s. 6d.; Siemens, £4 12s. 6d. to £4 15s.; and mild steel bars, £6 to £6 5s. But girder plates at £6 to £6 2s. 6d. are an improvement of half-a-crown upon January rates. On the other hand, angles, at £5 5s. to £5 10s, are, as regards the higher of these two figures, a decline of 2s. 6d. since the year opened. A great deal of competition from the Continent and from America marked the spring and summer.

Activity seems likely to characterise the Midland engineering trades during the early portion of the New Year, as there is a considerable amount of work in course of execution, and on order. The electrical and hydraulic branches have been busy throughout the twelve months, especially the former, and the railway carriage and wagon building firms have been well engaged both on railway and tramway necessities, and will probably continue so for some time. The motor car building trade has been busy, but the cycle trade has been only irregularly employed, and prices have had to face serious cutting. Edge tool makers have been well engaged on South American account, and moderately for South Africa and the West Indies. In the tube trade there has been a great deal of competition from Germany, Scotland, and America; some Midland firms have been active both on home and foreign orders, but others have been only quiet.

The Birmingham Chamber of Commerce has been co-operating with other chambers throughout the year on the question of railway rates and charges, and although no very definite results can as yet be pointed to, yet it is believed that the attitude of the traders will have a good influence by modifying future impositions.

The appointment of Professor Kapp to Birmingham has occasioned much satisfaction in Midland engineering circles. He has twice been the recipient of the Telford premium and medal. He first came to England in 1875, and was appointed engineer to Messrs. Crompton's works at Chelmsford in 1882. In 1885 he read a notable paper before the Institution of Civil Engineers, at which time it was only possible to buy a dynamo to light 60 incandescent lamps of 16 candle-power each. In that year he joined Mr. Allen, now the well-known manufacturing engineer, with works at Bedford, and the early dynamos of that firm were made to Mr. Kapp's designs. In 1894 he left England to become secretary to a German technical society, editing, at the same time, one of the German electrical publications, and he is now lecturing at the Charlottenberg Technical School.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The year closes better than was generally expected, judging from the outlook a few months ago, when the cotton industry in Lancashire was quite stagnant, and even up to within the past two or three months trade was of an indifferent character. The engineering, electrical, and tool-making departments have enjoyed fair vogue, but makers of textile machinery again complain of slackness of trade. In Manchester, Oldham, and Bolton this department is reported much worse than it was a year ago, though smiths and strikers had fair employment. The nut and bolt trade still continues depressed.

In pig iron there is a better feeling, and additional furnaces are reported to have been "blown" in in the North and Midlands. The striking feature of the week in this department was the sensational advance in Middlesbrough warrants, causing great firmness to rule in this centre. Indeed, quotations were withdrawn early on in the week, and makers would only consider the sale of small lots at an advance of 6d. to 1s on previous rates. Merchants took advantage in many cases to cover their forward requirements to some extent.

The attendance on 'Change on Tuesday was very fair considering the season, although it could not be said that a large amount of business was put through; and, except for finished iron and steel, quotations must be regarded as purely nominal. Owing to the advance in warrants there was more doing in Scotch pig iron, and the outlook is very promising, seeing that at the beginning of the year thousands of tons were being landed from America at the Manchester docks. Makers meantime continue well sold, and quotations are about as follows:—Lancashire No. 3 foundry, 53s. to 53s. 6d.; Lincolnshire No. 3, 51s. to 52s.; Derbyshire No. 3, 52s. to 53s.; Staffordshire No. 3, 52s.; Middlesbrough open brands nominally 55s. 10d. to 56s. 10d., with named about 6d. more. Scotch: Gartsherrie, 57s. 9d. to 58s. 6d.; Glengarnock, 56s. to 56s. 6d.; Eglinton, 55s. 6d. to 55s. 9d., delivered Manchester. Scotch, delivered Heysham: Gartsherrie, 55s. 6d. to 56s.; Glengarnock, 54s. 6d. to 54s. 9d.; Eglinton, 53s. to 53s. 6d. For forge iron there is little inquiry. Lancashire, 50s.; Derbyshire, 47s. to 48s.; Lincolnshire, 49s. to 49s. 8d., delivered Manchester.

Finished iron and steel do not call for much comment, but there is a very hopeful feeling amongst holders, in view of a probable

advance in certain quarters owing to the increased price of the pig iron. Staffordshire bars are firm, £6 5s. to £6 7s. 6d.; Lancashire and Yorkshire bars, £6 2s. 6d. to £6 5s., delivered stations; boiler plates, £6 17s. 6d.; hoops, £6 17s. 6d. to £7 2s. 6d.; sheets, ordinary, £7 5s.; ditto C.R. and C.A., £7 5s. to £8, delivered Manchester; steel bars, £6 to £6 2s. 6d.; English billets, £4 10s. to £4 12s. 6d.; German, £4 5s. to £4 7s. 6d.; hoops, £7 5s.

Raw copper remains very firm, but the demand for the manufactured article is quiet. Sheets, £78 to £80 per ton; seamless copper tubes, 10d.; ditto, brass, 8d.; rolled brass, 7½d.; copper wire, 9d.; brass wire, 7½d. per lb.

The fog greatly affected the movement in the coal market, and thousands of miners were for two or three days in enforced idleness, owing to the stoppage of traffic by the railway companies, and deliveries have been short, especially in house coal. For shipment also trade has been on a comparatively small scale. For engine slack the demand continues good, but for steam and manufacturing coal there is only an average request. Ordinary quotations are:—Best coal for domestic purposes, 13s. to 14s.; seconds, 12s. to 13s.; common, 9s. to 10s.; steam and forge coal, best, 8s. 3d. to 8s. 9d.; best engine slack, 7s. 6d. to 8s.; medium, 6s. to 6s. 9d.; common, 4s. 3d. to 5s. at the pit. Screened coal, 9s. 3d. to 9s. 9d.; unscreened, 8s. 9d. to 9s. 2d. delivered Manchester Ship Canal.

Barrow.—There are better indications all round in the hematite pig iron trade, and although at the moment the demand is quieter on account of the holidays, it is known that consumers of iron will require fuller deliveries in the New Year than they have been taking of late. Makers for the most part are more fully sold forward than for some time past, and they feel encouraged to put additional furnaces in blast, and are preparing others for early relighting if the state of the market justifies that course. Prices are firmer and higher at 57s. 6d. net f.o.b. for mixed Bessemer numbers, while warrant iron is at 57s. sellers at a month net cash, buyers 6d. less. The most remarkable thing in the present position is that warrant iron stocks are not being dealt in. They have stood at 12,342 tons for some weeks past. It might reasonably have been expected that these would be cleared with the improvement in prices which has set in. Warrants now-a-days are a negligible quantity; they are held in too small a bulk to exercise any influence on the ups and downs of the market, and have ceased to be speculative. There are now 28 furnaces in blast in the district, and it is expected this number will be increased to 30 early in the New Year.

Iron ore is in better demand, and the inquiries for deliveries in the New Year is much stronger than they have been Good average sorts are at 8s. 9d. per ton net at mines. Spanish ores are being imported more freely, and prices are a shade higher at 10s. to 11s. per ton net at West Coast ports.

The steel works in the district are stopped for the holidays, but makers have some fair orders to start the New Year with. The mills in the district are capable of turning out 11,000 tons a week, so that a pretty active market is required to keep them going, especially in view of the fact that other British makers have also a large producing capacity, while foreign makers produce much more steel than they did. Heavy rails are at 90s. per ton, but it is expected the operations of the International Rail Pool will ultimately lift prices to 110s. per ton. Light rails are quiet. Tram rails are doing a slow business. Merchant steel is depressed. Heavy steel castings are in small request.

Shipbuilders have booked no new orders. The preliminary trials of the British scout Sentinel, the first of its class, have proved highly successful, and the official trials are fixed for next week.

The Furness Railway Company has commenced to run a rail motor car on the Lakeside branch. It is capable of carrying fifty passengers, and is worked by steam.

Shipping is only moderately active. Last week's exports included 2670 tons of pig iron and 10,119 tons of steel, a total of 12,789 tons, in contrast with 8170 tons in the corresponding week of last year, an increase of 4619 tons.

Coal quiet. The demand for blast furnace coke is increasing.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

WORK was practically suspended last Saturday for the week, and the holidays appear, in spite of the fog, to have been enjoyed with as much zest as ever. Although the offices in several of the large establishments were re-opened on Wednesday morning, there was practically nothing done in the works except in very special cases, and operations will not be resumed until next week. In the South Yorkshire coalfield the holidays have not been so extended, operations recommencing in several instances on the 29th inst.

The year closed with a very firm demand for domestic fuel, but the exceptionally severe fog disorganised the railway service and prevented deliveries; the collieries were, therefore, unable to get rid of the full wagons, or obtain supplies of empties. House coal values are firmer, Barnsley house making from 10s. 6d. to 11s. per ton at the pits, secondary grades having also advanced in proportion. The steam coal market is in an unsettled condition, owing to the locomotive fuel contracts being still under suspense. The companies, it will be remembered, tendered at 8s. 6d.; this rate was declined by the railway companies, who offered 8s. The colliery owners placed revised tenders at 8s. 3d. per ton. Up to the time of writing no arrangement has been come to. Coke keeps slightly firmer, best washed samples being now quoted at from 10s. to 10s. 6d. per ton, but the ordinary market value is about 9s. 6d. per ton. Heavy deliveries are being made in gas coal, owing to the exceptional climatic conditions, and small coal maintains the improvement formerly reported.

The South Yorkshire coal trade for 1904 has been good with regard to volume, but unsatisfactory in respect of value. Prices have been drooping, and the working results are disappointing, such pits as have worked out their best seams and have relied on thinner and deeper coal, having had most difficulty to contend with, the expenses of working being greater and the profits less. The more important firms, however, have had a fairly satisfactory year, and even with trade at its worst were able to give their men four days' work per week. When the returns are available for the whole year, it will be found that the South Yorkshire output has been very large. With regard to steam coal, the business done with Hull for the eleven months ended 30th of November shows a weight of 3,271,648 tons, as compared with 3,166,384 tons for the eleven months of 1903. These figures exhibit the largest business done with the great Yorkshire port since 1900.

In house coal the year opened with a good trade doing at from 11s. to 12s. per ton at the pit mouth. During the summer quotations went down to 9s. per ton. At the end of September the coalowners announced a shilling per ton advance, but this was not maintained longer than about the middle of October, and December quotations for best Barnsley house coal are from 10s. 6d. to 11s. per ton. Small coal has been in indifferent demand during most of the year, through bad trade in the local glass bottle trade, the short time in the Lancashire cotton mills, and other causes; but during the autumn a change for the better set in, owing to cheaper cotton and the placing of large orders on Japanese and Russian account with Lancashire and Yorkshire mills. Good slack now makes about 6s. per ton, and secondary qualities 3s. 6d. to 4s. 6d. per ton.

The iron market has been most unsatisfactory throughout nearly the whole of the year. At the opening of 1904 the stocks in hand were heavy, and were slow in moving. In December, 1903, West Coast hematites were quoted at 65s. a ton, East Coast at 58s. In February, 1904, West Coast hematites had fallen to 63s., and East Coast remained at the old figure; but in April a slight improvement was visible, West Coast having advanced to 64s., and East Coast to 59s.; in July, West Coast were 6d. better, East Coast being unchanged. In September the improvement in West Coast had been lost, the quotation having returned to 63s., while East Coast had weakened to 57s. 6d. The closing month of the year finds West Coast hematites at 66s. a ton, and East Coast at 61s. In Lincolnshire foundry the price in February was 45s. 6d; Lincolnshire forge iron, 44s.; in April, Lincolnshire foundry was 46s., and forge 44s. 6d.; July found the former at 46s., but forge had fallen to 44s.; and in September there was a further fall, in foundry to 45s., and in forge to 43s. December, however, brought a decided improvement, foundry rising to 49s. and forge to 46s. 6d. Derbyshire irons have been obtainable on easier terms.

In the steel trade the principal business feature has been the continued demand for fast-cutting special steels, the use of which has been increasingly recognised in the engineering world. There are stated to be more than thirty brands of this steel made in Sheffield, a large market for which is found in the United States. One indirect result of its greater use is its favourable effect upon heavy machine tools, which are chiefly made in this country, as against the light machine tools, which are largely of American manufacture. The Bessemer and Siemens-Martin branches have been rather more active than crucible steel, except in the speciality mentioned. Bessemer billets and slabs have ranged from £6 5s. to £6 10s., and Siemens billets from £7 5s. upwards according to quality.

Importers of Swedish material have found this year very quiet, the diminished production of crucible steel, owing to the growing use of the special hard steels, having lessened the call for Swedish iron and steel.

The orders for military material received in Sheffield during this year have not been so large as usual. In 1903 the British Admiralty placed orders for armour plates with Sheffield manufacturers for five battleships and one cruiser, with extra casemates for H.M.S. Terrible and Royal Sovereign. This year armour has been ordered for three battleships—Hibernia, Britannia and Africa—building in the Government dockyards at Devonport, Portsmouth and Chatham. The weight was about 6000 tons. In August further orders, for about 1600 tons each, were given to two of the Sheffield firms for the three battleships named, and for the cruiser Natal, building at Barrow. The total weight for 1904 is therefore under 10,000 tons—work which any one of the three armour manufacturers in our city could complete within the year. For the Britannia and Hibernia the armour required is for the citadel, battery, barbette, conning tower, gun shield, port, and after-end protection; for the Africa, citadel, battery, barbette, conning tower, port, and after-end protection. For the cruiser Natal the Admiralty ordered armour for the citadel, battery, barbette, conning tower, and gun shield.

The re-armament of the British artillery will bring some good work to Sheffield in 1905. Messrs. Vickers, Sons, and Maxim, Limited, and Messrs. Cammell, Laird and Co., Limited, are the firms chiefly concerned. The bulk of the work to be done by Messrs. Cammell, Laird and Co., will go to their Coventry establishment, but that to be executed by Messrs. Vickers, Sons, and Maxim, will be chiefly done at Sheffield. The former firm, and Sir W. G. Armstrong, Whitworth and Co., have already received orders for these field guns. The order for the ten submarines, of course, will benefit the Barrow workpeople more than those of Sheffield, although part of the work will concern the departments at the river Don Works. There has been very little doing in projectiles during the year.

The lighter Sheffield trades, more especially cutlery, silver, and plated goods, have been far from brisk, although several of the larger houses had a fair amount of work for their employés, and report a very good Christmas and New Year demand. A difficulty, getting more acute with every sale, is the extraordinary advance in ivory, owing to the abnormally heavy buying on American account. Other hafting materials have also risen in value.

NORTH OF ENGLAND.

(From our own Correspondent.)

THOUGH, on account of the holidays, regular business has been quiet this week, there has been a good deal of excitement with regard to Cleveland warrants, speculation in which has been further stimulated by the optimistic reports from the United States, where the improvement that has appeared in the iron and steel trades appears to a great extent to be genuine. In the spring and summer of this year traders on this side were in fear that American pig iron would be invading our home markets, or, at any rate, neutral market. The news lately received has caused this fear to die out, and in its place the expectation has sprung up that the Americans in the coming year will become as good buyers of British pig iron as they were in 1902 and 1903, for it is believed that the demand for American pig iron will exceed the supply. Agents of some American houses have been in this district within the last fortnight, and one of the principal London firms, which did a large business on American account two years, is again buying, it is believed on the same account. Certainly some Cleveland pig iron has within the last few days been sold for early delivery to American consumers; indeed, the steamer is already chartered for carrying the first portion. There is also on order several thousand tons of spiegel iron for shipment from Middlesbrough to America.

The attention of speculators in Cleveland warrants is chiefly directed at present to American influences, and these have served to push prices up higher than ever, 50s. cash being reached; indeed, 50s. 9½d. was to be obtained on Tuesday, or more than has been reported for nearly two years. That was 9s. 1½d. per ton above the minimum price of the year, that being reported in January. But the point from which the present upward movement started was 42s. 3d.; 43s. was attained in September; 44s. in October; 45s. on November 3rd; 46s. on November 4th; 47s. on November 25th; 48s. on November 28th; 49s. on December 22nd; and 50s. on December 27th. Experienced traders believe that prices will continue to go up, especially as they have been rising in what is practically a holiday week. Speculators are coming forward in greater numbers to operate in warrants, but they are not confining themselves to these, as they are also buying shares in our leading iron and steel companies, and the market values of these have gone up considerably, more particularly the shares of North-East of England and Sheffield concerns.

On Tuesday 50s. 9d. cash per ton was obtainable for Cleveland warrants, and at Wednesday's close 50s. 2½d. Cleveland makers have put up the price of No. 3 to 49s. 6d. per ton, but one brand has actually realised 50s. As a rule consumers are not prepared to give either of these prices. The lower qualities are not so sensitive to the fluctuations in warrants, and they have gone up very little, indeed they are relatively much cheaper than No. 3. Thus No. 4 foundry can be bought at 46s. 6d.; No. 4 forge at 45s. 3d.; mottled at 44s. 3d.; and white at 43s. 3d. Cleveland warrants are inordinately high compared with both Scotch and hematite iron. Holders of Scotch warrants in the ordinary course of the market would be able to get 7s. per ton more for Scotch than for Cleveland warrants, but a difference of 3s. 6d. per ton is all that is reported.

The prospects are better for hematite iron makers, and prices move up, but at a much less rapid rate than is reported in connection with Cleveland No. 3 iron, the total advance in hematite being 4s. 6d., against over 9s. in Cleveland, but the improvement in the former is due to an actual improvement in the consumption demand, whereas the rise in Cleveland warrants has been chiefly induced by speculation. Mixed numbers of East Coast hematite pig iron are realising 54s. per ton, but to be on an equality with Cleveland No. 3 fully 5s. 6d. more should be realised. Rubio ore becomes dearer, and 15s. 6d. per ton c.i.f. Tees has now to be paid, though it must be stated that consumers are not at present prepared to give it, and buying is practically at a standstill.

The shipments of pig iron from the Cleveland district during December have been somewhat more satisfactory than were looked for. Up to 28th they reached 66,102 tons, against 62,802 tons in November, and 65,985 tons in December, 1903, to 28th. There can be no question that the exports for 1904 have been the smallest that have been reported for ten years—they will fall short of the 1903 exports by 17 per cent. At the same time stocks have increased very heavily, and of Cleveland iron in Connal's stores there is more than has been reported at any time during the last ten years. At the close of 1903 the stock was 99,953 tons, at July 6th it was only 78,013 tons, the smallest quantity for several years, but at December 28th there was 186,018 tons, an increase of 36,418 tons for the month, or 1500 tons per working day. Such an increase as this is unprecedented, and it is mainly brought about by the gamble in warrants. Every available ton of iron is sent into the public warrant stores, as a better price can be got for warrants than for makers' iron.

At the Lackenby Ironworks, Middlesbrough, plant is being laid down for the manufacture of slag wool.

The Cleveland Ironstone Miners' Association has under consideration the appointment of a third permanent official, the Executive Council having decided that the work is too arduous for Mr. Joseph Toyn, the agent, and Mr. G. B. Hobbs, the secretary, seeing that there are nearly 7000 members. The general body of miners are to vote on the question of Mr. William Stephens, the treasurer, being appointed the third permanent official, he to devote the whole of his time to the business of the association.

From next Monday Mr. Arthur Sladden, the secretary of the South Durham Steel and Iron Company, Stockton, will also undertake the duties of secretary of the allied concern—the Cargo Fleet Iron Company, and the general business offices of the latter company will be moved to the Moor Works, Stockton, from the Royal Exchange, Middlesbrough, where they have been for thirty-six years, ever since the Exchange was opened. Mr. J. J. Burton, who has been connected with the Cargo Fleet Iron Company for thirty-six years, having occupied the position of secretary since the company was made a limited liability concern twenty-two years ago, has resigned that appointment in order to act as assistant managing director, and he will take special charge of the ironstone mines, limestone quarries, coke ovens, and blast furnaces. Mr. Burton continues as managing director of the Tees Furnace Company, Limited, who are the owners of the Lackenby Ironworks.

The demand for finished iron and steel generally shows some improvement, and in some branches the manufacturers are fairly well supplied with orders for execution next quarter. Thus, prices are firmer, more especially those for materials required by shipbuilders, who are fairly off in this district. Orders for new steamers are being secured. Messrs. Constantine, Pickering and Co., of Middlesbrough, have ordered two cargo steamers, one of 5400 tons, to be built on the Tyne, and one of 6000 tons on the Tees; the engines for both are to be constructed on the Tees. For steel ship plates, £5 15s., less 2½ per cent., is the price; and for iron ship plates £6, less 2½ per cent. Steel ship angles are at £5 5s., and iron ship angles at £6 2s. 6d., both less 2½ per cent. Some improvement is expected in the steel rail trade.

With respect to the death of Sir Lowthian Bell, Bart., F.R.S., it may be stated that a memorial service was held on Friday at the parish church, Middlesbrough, at the same time as the funeral at East Rounton. This was very largely attended by the leading commercial men on Teesside and Tyneside. The Durham College of Science was represented by Lord Armstrong, Professor Bedson, and Mr. F. H. Pruen, secretary. The Dean of Durham—Dr. Kitchin—delivered a most able and appropriate address, in which he sketched Sir Lowthian's career. The King has communicated to the family of the late baronet the expression of his sincere sympathy.

Mr. T. R. Blumer, shipbuilder, has retired from the firm of Blumer and Co., Sunderland, and from business altogether, in order to devote his time and powers to the work of the men's Bible class, which he founded in Sunderland, a class which has a membership of 770.

The joiners and drillers at the shipyards on the Wear did not accept the recent general arrangement for a reduction of wages, but have had their cases considered separately, the question being referred to arbitration. Mr. Friend Lamb was the arbitrator. The employers claimed 1s. 6d. per week reduction on time rates and 5 per cent. on piecework. The decision is a reduction of 5 per cent. on piecework, but only 1s. on time rates.

Wages of steel millmen at Consett and other plate mills, which are regulated by the Consett sliding-scale, will not be altered in the first quarter of 1905, there being so little change in the realised price of steel plates. There has been no alteration in wages at these mills since March, 1903.

In the coal trade a rather slack time is reported, but that is looked for at this period of the year, and there is no material falling off in prices. Coke has not risen any further, and, generally, medium qualities can be bought at 14s. 9d. per ton, delivered at the furnaces on Teeside.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been practically little doing in the Scotch pig iron trade. While Christmas is not held so thoroughly as in the South, it is every year becoming more of a holiday; and indeed our holidays are getting prolonged, owing to the fact that, at the time of writing, we are entering upon the New Year holiday, which will extend over the greater part of next week. In some cases works will be closed for nearly a fortnight.

The Glasgow pig iron market was closed on Monday, and when it re-opened on Tuesday there was a brisk demand for warrants, which sent up prices further; but after considerable buying, a portion of the advance was lost. Business was done in Cleveland warrants from 49s. 7½d. to 50s. 4d. cash, 49s. 10½d. to 50s. 8s. for delivery from ten to twenty-seven days, and 49s. 10½d. to 51s. 1d. one month. Scotch warrants were quoted 54s., and Cumberland hematite 57s. 6d. per ton.

There has been a moderate demand for Scotch hematite pigs, which are quoted by merchants 58s. 6d. for delivery at the West of Scotland steel works.

The prices of Scotch makers' iron are in a number of cases 6d. to 1s. higher than last week. G.M.B., f.o.b. at Glasgow, No. 1, is quoted 55s.; No. 3, 52s.; Carnbroe, No. 1, 56s.; No. 3, 53s.; Clyde, No. 1, 58s.; No. 3, 53s.; Langloan, No. 1, 64s.; No. 3, 54s.; Gartsherrie, Summerlee, and Calder, Nos. 1, 58s. 6d.; Nos. 3, 53s. 6d.; Coltness, No. 1, 64s.; No. 3, 54s. 6d.; Glengarnock, at Ardrossan, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 54s.; No. 3, 51s. 6d.; Dalmellington at Ayr, No. 1, 53s. 6d.; No. 3, 51s.; Shotts, at Leith, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Carron, at Grangemouth, No. 1, 58s. 6d.; No. 3, 53s. 6d. per ton.

There are 85 furnaces in blast in Scotland, compared with the same number at this time last year, and of the total 41 are making ordinary, 38 hematite, and six basic iron.

The shipments of pig iron from Scottish ports in the past week amounted to 6905 tons, compared with 3312 in the corresponding week of last year, showing an increase of 3593 tons. The total shipments since the beginning of the year to date are 274,147 tons, being 37,379 less than in 1903.

The arrivals of Middlesbrough pigs at Grangemouth were 8780 tons, against 10,751 in the corresponding week, showing a decrease of 1971 tons. The aggregate imports of this class of iron for the year to date have been 481,275 tons, and there is a total decrease, compared with last year, of 97,554 tons.

The finished iron and steel trades have been quiet as regards the demand, but the works were generally well employed finishing off urgent orders before the holiday.

There has been a fair business in the coal trade, household coal being in special demand for home consumption at steady prices. The shipments of coal from the Scottish ports are 10,000 tons

better than in the corresponding week of last year, but they are 8000 tons less than in the preceding week. In the last few days, however, a considerable fleet of vessels have been loading with the object of getting clear away before the holidays. There is no change this week in the prices of shipping coal.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

FROM a glimpse obtained of the statistics of the year's trade in iron and steel, and in coal, it is evident that totals will be satisfactory. It is too early yet to give precise figures, but during the year, up to the end of November, the despatch of iron and steel from Cardiff amounted to 45,453 tons; from Newport, Mon., 17,635 tons; and from Swansea, 18,857 tons. During the same period Cardiff sent away in round numbers 16 million tons of coal, Newport nearly 4 millions, Swansea close upon 2 millions, Port Talbot nearly 1 million, Neath 280,000 tons, and Llanelly 306,000 tons, so that there was a grand total in coal shipments exceeding 24 million tons. The allied industries figured well:—Cardiff shipped 40,000 tons coke, and 431,000 tons patent fuel; Newport 17,635,000 tons coke, 47,622 tons patent fuel; Swansea 537,382 tons patent fuel, and 19,369 coke. Taking Cardiff ports alone a record is established, shipment coal, &c., being 20,929,000 against 20,272,465 for 1903.

A pleasing surprise is shown by the progressive business at Port Talbot, from which 13,000 tons coke and 112,000 tons patent fuel were shipped.

The "war item" of coal from Cardiff is about 1¼ million tons to two million tons.

Speculation is rife at Milford Haven as to the correctness of certain rumours by influential London journalists that it is probable estimates will appear shortly for a dry dock at Pembroke Dockyard. The Warrior, which was launched last spring, is expected soon to be ready, and the slips are being got ready for a still more powerful cruiser—the Defiance. This, as cited, will make the fifth contribution of Wales to the naval power of the kingdom, and if dry docks are formed the future promises large accessions, which will also aid the iron and steel trade.

In connection with the electric power supply of South Wales it is stated that the company will absorb the Carmarthen Company.

In reference to the important contract, now concluded between Cardiff shippers and the Transatlantique, I learn that the Cambrian, which invariably figures in big deals, obtained 10,000 tons for 13s. 3d., less the usual deduction; Insole, 50,000 tons; Ocean, 10,000, 13s. 3d. first-class brands; Great Western and Universal, 25,000 tons, cash. All of the coal was not first large Admiralties. Another French company—the Chofeurs Réunies—placed a contract lately for 70,000 tons at 12s. 11d.

With colliers enjoying three days' relaxation, and large numbers occupied on revival meetings, and dock offices thinly attended, there is not much to place in evidence of the work of the week, and anything like active business is only expected to date from Thursday. Last week there was a fair rush to clear, and it was noticeable at Cardiff on Saturday that four steamers left coal laden for Hongkong, the cargo totalling 18,700 tons. The week opened with few clearances, but one was again for Hongkong.

The latest reports from the Exchange, Cardiff, represent the coal trade as likely to be buoyant through the first weeks of the new year; that being the conclusion from business placed, and inquiries. Little change has occurred in dry coals, small steam, or in Monmouthshire semi-bituminous. House coal is steadily rising in tone, and a satisfactory character remains with patent fuel. Last week, Swansea, which retains premier position in exports of this make, despatched 10,465 tons, but the coal shipment, owing to fogs, barely exceeded 30,000 tons, of which France took a third.

The latest quotations at Cardiff last week may be taken as an indication of current prices this; best large steam at 13s. 3d. to 13s. 6d.; best seconds, 12s. 6d. to 13s.; ordinary seconds, 11s. 6d. to 12s.; drys, 11s. 9d. to 12s. 3d.; best smalls, 7s. to 7s. 3d.; best ordinaries, 6s. to 6s. 6d.; seconds, 5s. 6d. to 6s.; inferiors, including drys, 5s. to 5s. 3d.; best households, 16s. 6d. to 17s.; ordinaries and inferiors ranging from 10s. 6d. to 13s. 6d.; No. 2 Rhondda, 9s. 9d.; No. 3, 13s. 3d. to 13s. 6d. Patent fuel, 12s. 6d. to 13s. Coke prices are firm; 16s. to 16s. 6d. furnace qualities; foundry, 18s. to 18s. 3d. Pitwood has fluctuated, but left off at 17s. 6d. Newport Exchange issued this week the following notification of prices:—Best Monmouthshire, 11s. 3d. to 11s. 6d.; seconds, 10s. 9d to 11s. 3d.; Eastern Valley, 10s. 3d. to 10s. 6d.; smalls, 5s. 6d. to 5s. 9d.; house coals, 14s. 6d. to 15s. 3d.; seconds, 13s. 6d. to 14s. 3d.; smiths' coal, 8s. 9d.; screenings, 5s. 9d. Swansea has issued no list, so last week's figures may be taken as current. The condition of things in the coal district of Swansea is not satisfactory, three days' work being a common feature, and as fogs have delayed tonnage the situation is not improved. To add to the depressed condition several disputes are "on." Pitwood is selling at 19s. 6d, and substantial cargoes coming in from Spain.

The tenth steamer to the order of Messrs. John Cory and Sons, Cardiff, by the Northumberland Shipbuilding Company, Howdon-on-Tyne, was launched successfully last week. She is the single-deck type; dimensions are 335ft. over all; 48ft. breadth extreme; and 24ft. moulded. Deck erections consist of poop, long bridge extending forward and aft, fitted with trunked hatchways, and topgallant forecastle, she is built on the deep frame principle. Special attention has been paid to loading and discharging gear, and a complete outfit of powerful cargo and warping winches by Clarke, Chapman, and Co., Gateshead. Machinery will be supplied by Messrs. Richardsons, Westgarth and Co., Sunderland, with cylinders 23½in., 39in., and 64in. by 42in. stroke, and two boilers 15ft. diameter by 10ft. long, with a working pressure of 160 lb. per square inch. The vessel will carry 5200 tons on a light draught.

The new year promises well in motor business on railways. It has been arranged for a service from Barry to Porth, Barry to Cardiff, Barry to Bridgend, and carriages will shortly be ready. On the new branch line from Penrhos Junction on the Barry to Aber and connection with the Brecon and Merthyr, the railway is to be opened on January 2nd. The Board of Trade inspector is due this week to make inspection of the fine viaducts and lines of rail.

With reference to the motor business at Barry, it is expected that by the time the passenger steam traffic from Barry to Weston and Ilfracombe takes place next year—steamers now being in a fair way of completion—Barry will also have another motor service to the holiday haunts of the Glamorgan Valley.

Steady importations of iron ore from Bilbao, Passages, and other quarters, and lessened receipt of steel from Antwerp and Rotterdam, give an indication—authorities consider—that iron and steel prospects will open out more favourably with the New Year. It is to be noticed also that foreign ore prices are firmer. Cardiff and Newport quotations for Rubio are 14s. 6d. to 14s. 9d. These were 13s. 6d. to 14s. last week, also Tafna 14s. 6d., and Almeria 13s. 6d.; basis of 50 per cent. iron. Swansea quotations issued Tuesday give Rubio at 14s. ex ship.

In pig iron there has been a distinct advance on the week, as much as 2s. in Scotch, 2s. 5d. per ton in Middlesbrough, and 1s. 10½d. in Cleveland hematite.

In tin-plate there was again a large make, over 101,000 boxes coming from works. Holidays and fog interfered with shipments, so stocks show an increase to about 137,000 boxes. This, as vessels are loading for Russia, America, &c., will be lessened this week. Prospects of the trade are encouraging. Block tin has advanced £1 5s. to £1 10s. on the week, lead 1s. 3d., but spelter has fallen 7s. 6d.

Latest quotations, iron, steel, &c., are as follows, all Swansea:—Pig iron, Glasgow warrants, 54s.; Middlesbrough No. 3, 50s. 9½d.; Cleveland hematite, 57s. 4½d.; Welsh bars, £6 2s. 6d.; sheet iron, £8 7s. 6d. to £8 10s.; steel sheets, £8 5s. to £8 10s.; Bessemer steel bars, £4 5s. to £4 7s. 6d.; Siemens best, £4 7s. 6d. to £4 10s.; heavy rails, £4 15s. to £4 17s. 6d.; light, £5 15s. to £5 17s. 6d. Tin-plates: Bessemer steel coke, 12s. 9d. to 13s.; Siemens, 13s. to 13s. 3d.; ternes, 24s., 25s. 6d., 26s.; best charcoal, 15s. to 15s. 6d.; big sheets, £9 5s. to £9 10s.; finished black plate, £9 to £9 5s., both per ton; block tin, £134 5s.; spelter, £24 12s. 6d.; lead, £13; copper, £66 7s. 6d.

There is not much to report in respect of finished iron and steel. Dowlais continues busy with rails, and the Siemens department with sale billets. In the Swansea Valley an improved make of steel bar was shown. Blast furnaces busy, and up to holidays brisk work doing at Landore tube and at nickel factories.

Last notification given from Swansea Exchange:—That no fresh business is reported to any extent, but prices are advancing. Some friction in labour prevails at Lysaght's, Newport, but a satisfactory ending may be anticipated.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE pig iron market in Rheinland-Westphalia has been exhibiting more strength and liveliness this week than previously, and foreign as well as home inquiry has been increasing. While a short time ago only in foundry pig forward orders had been placed, last week most of the larger steel works in Rheinland-Westphalia, as well as in Belgium and France, have covered their demand for the greater part of next year from the "Union for the Sale of Siegerland Pig Iron." The blast furnace works that are connected with manufacturing establishments are better off than the pure blast furnace works, because the pig iron which they cannot dispose of is being consumed by their own concerns, whereas the latter in many instances have to reduce output up to 40 per cent. in order to make it equal to consumption. In the scrap iron trade offers exceed the demand, and quotations remain low, as only the most urgent requirements are being bought. The trade in bars moves on quietly. Hoops are in poor request; the orders received on home account are not sufficient to keep up a regular activity, and foreign contracts have to be taken at almost any price just to keep the mills going. Sheets are in moderate request, and heavy plates, too, are rather quiet.

A rise in the demand for most sorts of iron can be reported from the Silesian iron market. Inquiries on foreign account increase; several spring orders have already been secured, and the fact that producers in many cases stipulate for longer terms of delivery, speaks well for the condition of the market. In girders a brisk trade is done, orders being mostly for immediate delivery, and the majority of the mills are in active employment. Bars continue well inquired for and firm in price. Iron plates remain a trifle dull and neglected, and so are pipes generally; gas pipes, however, show a little more life than previously. The number of orders received at the railway and engineering shops has been increasing, and the terms of delivery asked by producers are longer than before.

Pig iron is decidedly firm and the better qualities inclined to rise in quotations. Latest list quotations are as follows:—Good forge pig, M. 56; iron for steel making, M. 58; spiegeleisen, M. 67 to M. 68, free Siegen; foundry pig No. 1 and hematite, M. 66 to M. 67; foundry pig No. 3, M. 63 to M. 64; raw bars, M. 77·50; rolled bars, M. 82·50; billets, M. 90; plates, M. 92·50; for Siemens-Martin quality M. 5 p.t. more is asked. Bars in basic, M. 108 free Oberhausen, M. 110 free Neunkirchen; merchant bars, M. 125, and for rivet and horseshoe quality, M. 135·50; hoops, M. 120; sheets, M. 118; heavy plates, M. 120 for merchant quality, and M. 150 for boiler plates; rolled wire, M. 120 to M. 122; drawn wire, M. 132·50 to M. 137·50, all per ton, free at works. Wire nails cost M. 16 per 100 kilos.

The production of pig iron in Germany, including Luxemburg, is officially stated to have been, for November of present year, 833,255 t. pig iron, of which 161,468 t. were foundry pig, against 147,017 t.; 22,966 t., against 38,901 t., Bessemer; 521,771 t., against 536,958 t., basic; 60,497 t, against 51,467 t., mild steel and spiegeleisen; and 66,553 t., against 68,487 t., forge pig. Output of pig iron in the Siegerland, as well as in the Lahn district and Hesse-Nassau, has increased; in Pomerania and Hanover and in Brunswick it was the same as before; and in all other districts a decrease in output could be noticed. In Rheinland-Westphalia 20,000 t. pig iron less have been produced in November of present year than in the same month last year.

On the 17th inst. the Wire Nail Convention was newly formed, the firm of Felten and Guillaume joining.

There has been a marked improvement felt in the demand for house coal on the Rhenish-Westphalian market, owing to the cold weather of the past few weeks. Gas coal, too, is in exceedingly good call, and sales in steam coal have been satisfactory. In coke production exceeds consumption; blast furnace coke is weak; while foundry coke meets with good request. A very active business is done in briquettes.

Both engine and house coal have been very briskly called for on the Silesian coal market. Shipments are heavy, and they are likely to remain pretty extensive during the next few weeks, as the sugar mills and several small industries purchase freely, and the requirements in house coal are likely to increase in consequence of the cold weather now prevailing.

Demand and sales in iron and steel have been of a somewhat moderate description on the Austro-Hungarian iron market last week. Bars and sectional iron meet with good request, and some spring orders for girders could be secured.

Consumption in coal is fairly extensive in Austria-Hungary, and coke has also been in strong request.

The iron trade in Belgium is fairly well employed. Pig iron has shown much steadiness. In basic some rather large orders have been obtained, and from the manufactured iron industry pretty good accounts have likewise been coming forward, rails and girders being particularly brisk of sale.

A moderate business is done in coal and coke on the Belgian market, and there was less done in engine fuel than previously. Briquettes remain firm.

Both the iron and the coal industry in France show comparatively little life. The tone is fairly steady though, and prices remain without change.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, December 21st.

DURING the past few days the United States Steel Corporation has contracted for 40,000 tons of Bessemer iron and 26,000 tons of basic, and is trying to increase its supply of steel-making irons to a considerable extent. Prices, in consequence, are very firm. Contracts have been recently placed by the United States Cast Iron Pipe and Foundry Company for 15,000 tons of Virginia foundry iron, and other large buyers have contracted for 30,000 tons of standard and malleable Bessemer, who have already purchased 40,000 tons of basic. These very heavy purchases lead conservative buyers to apprehend a further advance. This policy of buying stocks for future contingencies is in harmony with the policy pursued two years ago. Much bars are also being rapidly bought. The curtailment in the production of coke is making trouble, and a number of foundries are now practically out of stock. The Connellsville foundry is held at 2·25 dols. up as high as 3 dols.

The railroad companies are contracting for supplies of rails, and various estimates have been given out as to the probable demands between now and the end of the year. Next year's production may possibly reach 3,500,000 tons, which will be fully half a million tons in excess of the output of the current year. Billets will be advanced 2 dols. per ton this week, and advances on other lines are anticipated. Beams, angles, and tees will also be moved from 2 dols. to 4 dols. per ton.

The copper market is at last quiet. Tin-plate manufacturers are holding prices firmly at the advance. Last Saturday 290 tons of tin arrived from London; total receipts this month, 1227 tons.

Many lines of hardware have been advanced in price in consequence of higher prices of iron and steel. Another advance is due in wire nails. Builders' hardware is in very active demand on account of the numerous operations in progress.

The tone of the entire market is strong, and there are some reasons for anticipating a higher level of prices, not only in all kinds of crude material, but in all lines of hardware, machinery, and equipment. A stimulus has been imparted to the development of copper properties, and many properties which attracted only a passing attention six months ago are now in the market, and developments will be prosecuted rapidly. An attempt will be made to enact national legislation for the purpose of establishing control over railroad rates, and it is understood that the managers of all the larger systems are in favour of some concession to public sentiment on this point. It is not probable that this legislation will be secured this winter.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market.—Owing to the collieries not having resumed work, no reliable quotations can be given as to prices, and the same applies to the house coal trade. The quantity of coal shipped for the week ending December 24th was 86,230 tons; foreign, 68,199 tons; coastwise, 18,031 tons. Imports for the week ending December 27th:—Iron ore, 11,780 tons; manganese ore, 3220 tons; bars, 2920 tons; pig iron, 225 tons; oak timber, 1048 tons; pitwood, 3468 loads.

Coal—Best steam, 11s. 3d. to 11s. 9d.; seconds, 10s. 6d. to 10s. 9d.; house coal, best, 15s.; dock screenings, 6s. to 6s. 3d.; smiths' coal, 9s. Pig iron—Scotch warrants, 53s. 7½d.; Middlesbrough No. 3, 50s. ½d.; Middlesbrough hematite, 57s. 6d. Iron ore—Rubio, 14s. 6d. to 14s. 9d.; Tafna, 15s. 6d. to 15s. 9d. Steel—Rails, heavy sections, £4 15s. to £4 17s. 6d.; light ditto, £5 15s. to £5 17s. 6d.; Bessemer steel tin-plate bars, £4 5s. to £4 7s. 6d.; Siemens steel tin-plate bars, £4 7s. 6d. to £4 10s., all delivered in the district, cash. Tin-plates—Bessemer steel, coke, 12s. 9d. to 13s.; Siemens, coke finish, 13s. to 13s. 3d. Pitwood—No quotations. London Exchange telegrams—Copper, £67 5s. to £67 7s. 6d.; Straits tin, £133 12s. 6d. to £133 15s.

TRADE AND BUSINESS ANNOUNCEMENTS.

PRIESTMAN BROTHERS, Limited, inform us that their London address is now 3, Laurence Pountney-hill, Cannon-street, E.C.

ON the 2nd January next A. Ransome and Co's., Limited, London office will be removed from Chelsea to 63, Queen Victoria-street, E.C.—three doors from the Mansion House Station.

MR. E. KILBURN SCOTT, M. Inst. E.E., A.M. Inst. C.E., has been appointed to organise and take charge of the electrical engineering department at Sydney University. In addition to lecturing duties, he will continue his consulting practice.

MR. E. T. BEARD, A.M. Inst. C.E., engineer of the Marine Drive Works, Scarborough, has been awarded a silver medal at the St. Louis Exhibition for photographic views showing the construction of the new sea wall at Scarborough, which was completed last month.

MR. PHILIP S. DOHERTY informs us that he has resigned his appointment as manager of the English branch of Messrs. Henry Pels and Co., of Berlin, Germany, prior to taking up another appointment as head engineer to Paul J. Mallmann, Esq., of 114, 116, and 118, Victoria-street, London, S.W.

MR. A. J. LAWSON, M. Inst. C.E., having tendered his resignation in September last as chief electrical engineer to the British Electric Traction Company, Limited, and its associated undertakings, which he has held for the past three years, severs his connection therewith at the end of the present year. He will continue to practise as a consulting engineer at his present address, 4, Adelphi-terrace, Strand, London, W.C.

MESSRS. SHIPPEY BROTHERS inform us that they have disposed of their entire interest in the leases and goodwill of the Central Motor Car Emporium, also the American Motor Car Agency, as carried on by them for the past two years at 117 and 118, Long Acre, to the Central Motor Car Company, Limited, of 18, Billiter-street, E.C., who have secured the sole British rights in the Ford motor car for sale in the United Kingdom.

MR. G. P. WILSON and Mr. W. A. WALBER have entered into partnership; the firm will be styled Wilson and Walber, carrying on business as merchants and engineers at 38, Victoria-street, Westminster. Mr. Wilson is the eldest son of the late Mr. George Wilson, for many years chairman of Charles Cammell and Co., Limited, of Sheffield. Mr. Walber has been connected for many years with the same firm, holding an important position.

MESSRS. FINCH AND CO., Limited, of Chepstow, have despatched three special trains to Tilbury Docks, with the whole of the iron and woodwork, pumps, &c., for a large caisson 85ft. in length, 26ft. breadth, and 40ft. 3in. in depth, the weight being about 420 tons—without permanent ballast—for shipment per the s.s. Loch Tay, the whole having been constructed, put together, marked and numbered for re-erection at Colombo, from the designs and under the superintendence of Messrs. Coode, Son and Matthews, engineers, of Westminster. The caisson is for closing the entrance to the large new graving dock now in course of construction at Colombo, and has been built to the order of the Crown Agents for the Colonies.

NAVAL ENGINEER APPOINTMENTS.

THE following appointments have been made at the Admiralty:—

Engineer Commanders.—W. R. Apps, to the Vivid, for the Renown; and J. G. L. Baker, to the Vivid, for the Hibernia.

Engineer Lieutenants.—G. H. Cockey, D.S.O., to the Firequeen, for the Wear; W. A. Wallis, to the Tamar, for the Otter; T. H. B. Bishop, to the Firequeen, for the Barham; and C. Broadbent, to the Hussar, on recommissioning.

THE new French battleship Patrie is to receive as part of her armament a new and more powerful type of 17·7in. torpedo, the pressure in the air chamber being 2133 lb., instead of 1280 lb. to a square inch. This torpedo, says *Le Yacht*, will also be supplied to all battleships following the Patrie, to the Jules Ferry, and all later cruisers.

CONTRACTS.—Messrs. Scott's shipbuilding and Engineering Company, Greenock, has received an order to build a screw steamer of 2000 tons for the China Navigation Company, Limited, London, the vessel to have triple-expansion engines of 2000 indicated horse-power. Messrs. D. J. Dunlop and Co., of Port Glasgow, have contracted to build and engine a screw steamer for the Northern Steamship Company, of New Zealand.—Messrs. James Watt and Co., of Soho Foundry, Birmingham, have received from the South Staffordshire Waterworks Company an order for the engines and pumps for its Conegre Pumping Station, Dudley.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

13th December, 1904.

27,112. Locking Mechanism for Carriage Doors, W. Thompson, Oulton Broad, near Lowestoft.
27,113. Detachable Shade for Lamps, W. F. Freeman, London.
27,114. Operating Gear for Points of Tramways, A. C. Virgin, Bristol.
27,115. Reverse-current Circuit Breakers, L. Andrews, Manchester.
27,116. Metallic Fancy Boxes, F. F. Empson, London.
27,117. Actuating the Clutches of Motor Cars, E. Turner, London.
27,118. Hydro-extractors, T. Cudlipp, London.
27,119. Filling Bottles with Fermented Liquids, T. H. Clayton, London.
27,120. Dye for Making Tiles, H. Clarke, Turnstall, Staffs.
27,121. Cleaning Drinking Glasses, H. A. Dulson, Wolverhampton.
27,122. Three-speed Gear for Motor Vehicles, F. Dunderdale, Manchester.
27,123. Four-cycle Explosion Engines, T. G. Wright, Bristol.
27,124. Candle Making Apparatus, J. Fearnhead, Bolton.
27,125. Automatic Temperature Alarm, W. T. Munro, Cumbernault.
27,126. Illuminated Apartment Card, A. Walley, London.
27,127. Closing the Dividing Bowls of Tea Infusers, W. Pearce, Birmingham.
27,128. Outdoor Seat, J. Scott. Manchester.
27,129. Harness Buckles, G. Shoenberger, London.
27,130. Scrap and Invoice Book, C. E. Blodgett, London.
27,131. Scissors, W. E. Wahlin and L. Jacobsen, London.
27,132. Revolving Cabinets. S. M. Holt, London.
27,133. Bookcases, S. M. Holt, London.
27,134. Pipe Wrenches, J. J. Layton, London.
27,135. Hangers for Overhead Electric Trolley Cars, H. Heap, J. Bailey, T. Brierley, R. Billington. A. Richardson, J. Haydock, and T. S. Jones, Manchester.
27,136. Taps, H. G. Mason, Birmingham.
27,137. Automatic Gear Variation, T. Lewis and H. Gibbs, Birkenhead.
27,138. Tagging Tubes for Drawing Purposes, W. G. Moore, Birmingham.
27,139. Can-opening Machine, E. G. Hentsch, Nottingham.
27,140. Mechanism for Raising Sliding Glass Frames, T. W. and A. G. Robinson, Manchester.
27,141. Coloured Photography, H. Dahl, Liverpool.
27,142. Brakes, W. P. W. Weatherill, Manchester.
27,143. Golf Club, C. E. Clark, London.
27,144. Mounting Photographic Prints, W. Watson, Glasgow.
27,145. Wheels for Heavy Vehicles, G. H. Halley, Glasgow.
27,146. Machines for Making Pies, D. S. Williams, Manchester.
27,147. Sanitary Cover for Drains, E. Tranter, Wolverhampton.
27,148. Harness for Animals, J. Schreven, London.
27,149. Driving Gear for Motor Vehicles, P. G. Tacchi, London.
27,150. Dress Fasteners, F. R. Francis, London.
27,151. Door Handles, R. A. Briggs, London.
27,152. Safety Locking Devices for Lifts, A. Whelan, London.
27,153. Driving Airships, W. E. Burton, London.
27,154. Ventilating Boots and Shoes, H. C. Munro, London.
27,155. Coin-operated Game, H. C. Munro, London.
27,156. Automatic Brush Mat, H. C. Munro, London.
27,157. Cycles, H. C. Munro, London.
27,158. Rotating Washer Scrubbers, H. S. Smith-Rewse, London.
27,159. Hoist-drums, A. Frohn, London.
27,160. Rolling Mills, E. Ebinghaus and A. Schumacher, London.
27,161. Turning Shovel Dredgers, A. Bode and K. Böttcher, London.
27,162. Explosive Compounds, C. A. Allison.—(*A. Muller-Jacobs, United States.*)
27,163. Smithy's Fire Grate, C. Katzschke, London.
27,164. Power-transmission Gear, V. H. Gregory, London.
27,165. Logging Tree, R. Whitton, London.
27,166. Manufacture of Explosives, L. Lheure, London.
27,167. Manufacture of Detonating Tubes, L. Lheure, London.
27,168. Automatically Regulating Voltage, M. J. E. Tilney, London.
27,169. Construction of Bogies, L. A. Timmis, London.
27,170. Finger Rings, L. H. McCormick, London.
27,171. Obtaining Oxide of Zinc, A. Gutensohn, London.
27,172. Automatic Closures for Bottles, H. Dubois, London.
27,173. Machine for Manufacturing Fire-lighters, H. Vogt, London.
27,174. Preventing Doors from Opening, O. Messerschmidt, London.
27,175. Lock Bolt, J. Edwards, London.
27,176. Lining Material for Harness, A. Kessler, jun., London.
27,177. Building Stones, F. Schaub, London.
27,178. Spirit-level Attachments for Ordnance, F. Krupp Akt.-Ges., London.
27,179. Mechanical Device for Teaching Arithmetic, A. Leitch, London.
27,180. Filters for Water, C. E. Chamberland, London.
27,181. Die Stocks, O. F. Kadow, London.
27,182. Refrigerating Engines. D. McGill. London.
27,183. Cooking Apparatus, F. Kahn, London.
27,184. Internal Combustion Engines, A. Brolliet, London.
27,185. Electric Conductors, F. W. Sorg, London.
27,186. Drills, H. H. Lake.—(*The Ingersoll-Sergeant Drill Company, United States.*)
27,187. Case-hardening Cementation, W. H. W. Proctor and W. Morgan, Coventry.
27,188. Hot-water Boilers of Kitchen Ranges, J. D. Prior, London.
27,189. Rope-gripping Devices, M. Graham, London.
27,190. Pneumatic Tires, J. Russell, London.
27,191. Glass Tiles, Maw and Co., Limited, and C. H. Thompson, London.
27,192. Stone Bottles, H. T. Bead, London.
27,193. Steam Whistles, C. S. Huess, London.
27,194. Covers of Luteless Gas Purifiers, F. Mardon, London.
27,195. Vehicle Wheels, F. Eames, London.
27,196. Protecting Fragile Articles, W. R. Comings, London.
27,197. Paper Corks or Stoppers, W. R. Comings, London.
27,198. Concrete Piles, J. Y. Johnson.—(*The Simplex Concrete Piling Company, United States.*)
27,199. Excitation of Electrical Machines. Siemens Bros. and Co., Limited.—(*Siemens Schuckertwerke, G. m. b. H., Germany.*)
27,200. Railway Signal Lamps, W. H. I Welch, London.
27,201. Electrostatic Wattmeters, E. Wilson, London.
27,202. Stereoscopes, E. Burnet, Liverpool.
27,203. Fastening for Wooden Boxes, A. P. Heyman, Liverpool.
27,204. Railway Couplings, W. W. Wright, Liverpool.
27,205. Driving Gear for Motor Vehicles, H. T. Hansen, London.
27,206. Driving Gear for Motor Vehicles, H. T. Hansen, London.
2 ,207. Transferring Designs to Printing Rollers, P. J. Lamp'l, London.
27,208. Trunks, B. and K. Rosenbaum, London.
,209. Electric Operation of Railways, J. H. Hallberg, London,
27,210. Making Measurements on Fabrics, E. Kessler, London.
27,211. Protection of Electric Distribution Systems, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
27,212. Paper Bag, J. H. Hunt, London.
27,213. Adjustable Rule Square, F. Sundermann, London.
27,214. Briquetting Compositions, H. L. Mitchell and the Briquettine (Minerals Binding) Company, Limited London.

14th December, 1904.

27,215. Sorting Needles, &c., F. Iles, Studley, R.S.O., Warwickshire.
27,216. Sorting Needles, &c., F. Iles, Studley, R.S.O., Warwickshire.
27,217. Telegraphic Transmitters, J. Esser, Cologne, Germany.
27,218. Enabling the Blind to Read and Write, J. Whitaker, Sheffield.
27,219. Target Game, F. Gingell and W. James, Manchester.
27,220. Projectiles, H. J. Trautmann, London.
27,221. Chairs for Railways, J. and E. Gunnill, Goole.
27,222. Copper Engraving and Etching, D. C. Paterson, Glasgow.
27,223. Indicating Defective Eyesight, J. J. Wood, Liverpool.
27,224. Attaching Soles to Boots, W. Hurrell, Norwich.
27,225. Joints for Cornice Poles and Curtain Rods. A. Oakden and Sons, Limited, and A. E. Oakden, Birmingham.
27,226. Tin Cans, F. P. Smith and S. F. Hadfield, Halthwhistle, Northumberland.
27,227. Recharging of Carburetters, A. Jaray, Manchester.
27,228. Steam Coil Ventilator, J. Langfield, Manchester.
27,229. Bracelets, G. E. Lancelott, Birmingham.
27,230. Stiffening of Hat Brims, J. A. and J. Gaunt, York.
27,231. Wheels, W. McConnell, Glasgow,
27,232. Oven Flues, D. R. Wilson, Glasgow.
27,233. Knitting Machines, J. H. Smith and O. A. Hill, Nottingham.
27,234. Knitting Machines, J. H. Smith and O. A. Hill, Nottingham.
27,235. Envelope, G. G. B. and L. M. Swifte, Dublin.
27,236. Candlesticks, T. Archer, Gateshead-on-Tyne.
27,237. Automatic Gas Generator for Oils, J. Berry, Northampton.
27,238. Skill Game, E. V. Salaman, Lower Behington, Cheshire.
27,239. Signalling Apparatus, E. T. Whitelow and G. H. Scholes, Manchester.
27,240. Feeding Devices of Sewing Machines, W. Mycock and W. H. Cottam, Manchester.
27,241. Boilers, W. J. Greaves, London.
27,242. Fittings for Window Blinds, A. Clarke, London.
27,243. Azimuth Mirrors, P. W. M'Grath, London.
27,244. Records for Phonographs, F. W. Jackson, London.
27,245. Mercury Vapour Lamps, O. D. Lucas, London.
27,246. Electrical Measuring Instruments, Siemens Bros. and Co., Limited, and E. A. Holmes, London,
27,247. Beam Compasses, R. Jensen, London.
27,248. Steam Generators, Société Anonyme du Temple, London.
27,249. Device for Extinguishing Lamps, H. L. Todd, London.
27,250. Bottle-filling Apparatus, F. W. Margetts, London.
27,251. Stoppering Bottles, F. W. Margetts, London.
27,252. Reducing Metallic Oxides, H. Marandon, London.
27,253. Apparatus for Increasing the Length of Stride in Walking, R. Michael, London.
27,254. Massage Machines, J. M. Tourtel and G. L. Hogan, London.
27,255. Railway Signalling, J. Wheatley, jun , East Molesey, Surrey.
27,256. Driving Mechanism, C. Payne, London.
27,257. Paper-feeding Mechanism, C. Payne, London.
27,258. Production of Lime, G. P. and M. Wallis, London.
27,259. Constructing Concrete Piles, A. Strauss, London.
27,260. Apparatus for Electrode-deposition, A. J. Betteridge, Birmingham.
27,261. Valves, J. A. Fletcher and H. Wilcock, London.
27,262. Gas Stove, A. Verwey, London.
27,263. Locating Articles in the Dark, C. C. Hooley, London.
27,264. Iron Clubs for Golf, H. Logan, London.
27,265. Tie Retainer, A. L. Hannay, London.
27,266. Preparing Food Products Containing Iron, C. Aufsberg, London.
27,267. Artificial Lighting for Photographic Purposes, G. Krebs, London.
27,268. Artificial Lighting for Photographic Purposes, G. Krebs, London.
27,269. Wheel Spokes, A. A. Day, Liverpool.
27,270. Fabrics, H. Sarafian, London.
27,271. Motor Road Vehicles, W. B. Megone, London.
27,272. Lifeboats, R. D. and R. D. Mayo, London.
27,273. Metal Finishing Processes, A. H. R. Allen and H. S. Darby, London.
27,274. Cricket Bat Handles, F. H. and S. F. Ayres, London.
27,275. Billiard Markers, H. R. Wildish, London.
27,276. Coke Furnaces, E. Dury and O. Piette, London.
27,277. Perforating Machines, J. S. Bancroft, London.
27,278. Mechanism for Type Machines, J. S. Bancroft, London.
27,279. Box-making Machines, A. T. Spencer and E. C. Wykes, London.
27,280. Fluid-pressure Engines, A. Craig, Coventry.
27,281. Printing Machine Appliances, F. W. Vickery, London.
27,282. Facing Tools, Mayor and Coulson, Limited, and A. W. Davies, London.
27,283. Vehicles for Preventing Side-slip, N. Goddard, London.
27,284. Apparatus for Turning over Leaves of Music, A. Levi, London.
27,285. Emergency Brakes, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
27,286. Valves for Fluid Pressure Systems, The British Thomson-Houston Company. Limited.—(*The General Electric Company, United States.*)
27,287. Brakes for Hoists, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
27,288. Wheel Rims of Motor Cars, J. H. Barry, London.
27,289. Purification of Sugar, A. Kollrepp and A. Wohl, London.
27,290. Furnace Hoists, J. Pohlig Akt.-Ges , London.
27,291. Seats of Railway Vehicles, H. H. Lake.—(*R. G. Budd, United States.*)
27,292. Manufacture of Sulphurised Dyestuffs, C D. Abel.—(*Akt.-Ges. für Anilin Fabrikation, Germany.*)
27,293. Apparatus for Surfacing, H. S. S. Watkin and C. J. Foster, London.
27,294. Brakes for Railway Vehicles, J. W. Cloud, London.
27,295. Doors for Smoke-boxes of Boilers, T. Thompson, London.
27,296. Grinding Nuts and Boltheads, E. H. Schmidt, London.
27,297. Means for Lighting Gas Lamps, G. Giorgi, London.

15th December, 1904.

27,298. Metal Sheath for Sadiron, T. H. Neale, West Bromwich, Staffs.
27,299. Lubricating Devices for Wheels, A. Knüttel, Barmen, Germany.
27,300. Sieves, F. Wissmann, Barmen, Germany.
27,301. Duplicating Check Books, A. Gilbert, Kidderminster.
27,302. Ventilation for Incubators, J. A. Hooper, London.
27,303. Circular Saw Benches, J. Denholm, Glasgow.
27,304. Pumps for Extracting Water, C. Day and W. A. Dexter, Glasgow.
27,305. Fittings for Fishing-rods, C. Bird, Studley, R.S O., Warwickshire.
27,306. End Rings for Fishing Rod Joints, C. Bird, Studley, R.S.O., Warwickshire.
27,307. Regenerative Gas Furnaces for Melting Steel, J. Izzett, Glasgow.
27,308. Tar Paving, J. Ward, Liverpool.
27,309. Tar Paving, J. Ward, Liverpool.
27,310 Electric Glow Lamps, C. E. Abell, Birmingham.
27,311. Securing Consumption of Smoke in Steam Boilers, G. Stocks, Huddersfield.
27 312. Door Furniture, D. MacRae. Manchester.
27,313. Tires for Motor Cars, J. Robertson, Manchester.
27,314. Game, E. F. Barnes, Birmingham.
27,315. Cycle Brakes, J. Kellard, jun., and E. Kellard, Birmingham.
27,316. Billiard Tables, B Hulbert, Bristol.
27,317. Reflection in Electric Lights, T. D. Jackson, Stockton-on-Tees.
27,318. Flageolet, D. G. Rees, J. D. Morgan. W. G. and T. G. Rees, Seven Sisters, near Neath, Glam.
27,319. Holding Bolts in Metal, T. Eaton, Liverpool.
27,320. Combination Musical Instrument, C. P. Scovell and T W. Lewis, Edinburgh.
27,321. Hammer Handle, G. Nairn, London.
27,322. Motor Car Fittings, C. W. H. Scott, Carlisle.
27,323. Racing Hurdles, J. Walton, Manchester.
27,324. Turbines, A. J. Cooper, Liverpool.
27,325. Grinding Tramway Rails, H. Mattinson, Sale, Cheshire.
27,326. "Key" or Rough Backing to Glass, W. Richards, London.
27,327. Hand Ball Game, T. Burrows, Staines, Middlesex.
27,328. Hammer Head Fastener, M. and J. R. Morris, Gateshead.
27,329. Driving Machines, G. Kunick, London.
27,330. Raising and Lowering Windows, T. Brierley, Dublin.
27,331. Throttle Valves for Engines, J. B. Butterfield, Leeds.
27,332. Machines for Milling Fabrics, S. and B. Preston, Leeds.
27,333. Slide Valves of Engines, J. Gallacher, London.
27,334. Tools for Stone-working Machines, W. L. Ree, London.
27,335. Motor-propelled Vehicles, J. W. Cross, London.
27,336. Golf Balls, J. W. and E. Hartley, Stone, Staffs.
27,337. Scarifying Machines, W. Allwood and H. Garner, Liverpool.
27,338. Book and Magazine Covers, W. E Richards, London.
27,339. Joining Sheet Plates, B. Hiernaux and H. Iaviole te, London.
27 340. Smelting and Heating Iron, G. A. Jarvis, London.
27,341. Pins for Fastening Hats, &c., J. H. Havers, London.
27,342. Mantles for Incandescent Gas Burners, W. H. Akester, London.
27,343. Removing Corks from Interior of Vessels, F. Podlaszecki, London.
27,344. Razor Finder, J. G. Baker, London.
27,345. Non-skidding Tires, W. B. Hartridge, London.
27,346. Boot Machinery, A. Harrington and W. Spiers, London.
27,347. Preventing Skidding of Road Vehicles, W. E. Vincent, London.
27,348. Electrical Switches, G. Eason, London.
27,349. Gas Burners, A. H. Arzt and S. Baron, London.
27 350. Non-conductors of Heat, W. H. Mohn, London.
27,351. Pulleys for Driving Chains. The Westinghouse Brake Company, Limited —(*The Morse Chain Company, United States.*)
27,352. Electric Controlling Apparatus, Otis Elevator Company, Limited.—(*Otis Elevator Company, United States.*)
27,353. Fire Engines, J. Sutcliffe, Burnley.
27,354. Mechanical Stokers, P. R. J. Willis.—(*W. H. Strouse, United States*)
27,355. Wrenches, J. Doyle, Kingston-on-Thames.
27,356. Cleansing Polished Wood, J. Stevenson and E. H. Cox, London.
27 357. Wearing Apparel, H. S. Saunders and W. J. Cruske, London.
27,358. Saving Carbonic Acid Gas in Aerated Water, E. P. Coulter, London.
27,359 Mantles for Incandescent Gas, W. H. Akester, London.
27,360. Machines for Loading Hay, F. M. Waller, London.
27,361. Carburetters, F. de Mare, London.
27,362. Windows, C. E. König, London.
27,363. Cycle Frames, J. E. Elkin, London.
27,364. Friction Clutches, M. Graham, London.
27,365. Cleaning Producer Gases, B. Talbot, London.
27,366. Hoisting Gear, R. Priest, B. Millward, and W. Morrall, Birmingham.
27,367. Railway Carriage Windows, J. O. Newton, London.
27,368. Steam Generator Furnaces, W. H. Longsdorf, London.
27,369. Starting Internal Combustion Engines, J. Day, London.
27,370. Window Blind Rollers, W. E. Smith, London.
27,371. Sand Sprinkling Machines, L. Weissenbock and A. Beschorner, London.
27,372. Construction of Ceilings, H. Westphal, London.
27,373. Production of Oxyanthraquinones, H. E. Newton.—(*Farbenfabriken vormals F. Bayer and Co., Germany.*)
27,374. Production of Oxyanthraquinones, H. E. Newton.—(*Farbenfabriken vormals F. Bayer and Co., Germany.*)
27,375. Camera Shutters, W. F. Butcher, London.
27,376. Thermometers as Fire-alarms, H. Fairfield, London.
27,377. Heels of Boots and Shoes, J. W. Hale, London.
27,378. Fluid-pressure Motors, J. W. Tierney, London.
27,379. Temporary Binders, W. P. Thompson.—(*H. F. Bushong, United States.*)
27,380. Boxes, J. Ollier, Liverpool.
27,381. Milking Pail, J. Hamilton, London.
27,382. Admission Valves for Engines, J. M. Ferguson, London.
27,383. Variable Speed Mechanism, C. J. M. Erade, London.
27,384. Utilising Photography for Identification of Living Objects, H. J. Haddan.—(*M. C. A. F. Duchanoy, France.*)
27,385. Celestial Globes, F. Malitus, London.
27,386. Railway Carriage Windows, W. F. Williams, London.
27,387. Variable Speed Gear for Cycles, A. Stone, London.
27,388. Flooring, A. W. Cooksey, London.
27,389. Manufacture of Blotting Paper, A. Barker, London.
27,390. Leguminous Protein, W. M. Williams and F. Hutchins, London.
27,391. Non-alcoholic Beverages, W. M. Williams and F. Hutchins, London.
27,392. Compressing Gases, R. B. Ransford.—(*Michelin et Cie , France.*)
27,393. Furnaces of Steam Generators, H. L. Davies, London.
27,394. Steam Generators, C. Bellens, London.
27,395. Looms for Weaving, M. A. Adam, London.
27,396. Collecting Carbonic Acid Gas, J. C. Stead and T. C. Palmer, London.
27,397. Peat Fuel, Central Torfkohlen G. m. b. H., London.
27,398. Collapsible Box, R. R. Reichenheim and L. F. Marshall, London.
27,399. Electricity Meters, W. Hamilton and Ferranti, Limited, London.
27,400. Systems of Electric Motor Control, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
27,401. Electric Motor Control Systems, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
27,402. Maximum Demand Electric Indicators, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
27,403. Maximum Current Indicating Devices, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
27,404. Metal Working Machines, The British Thomson-Houston, Company, Limited. — (*The General Electric Company, United States.*)
27,405. Vehicle Wheels, F. F. Mote. London.
27,406. Vacuum and Filter Tilting Press, J. F. Webb, London.
27,407. Extracting Liquids from Minerals, J. F. Webb, London.
27,408. Removing Moisture from Air, E. Hesketh and H. Brier, London.
27,409. Wheels for Motor Vehicles, G. Perruchon, London.

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27,410. Fog Signalling Apparatus, G. H. S. Bailey Worksop, Notts.
27,411. Meat Slicing Machine, A. Lutzmann, Barmen, Germany.
27,412. India-rubber Toilette Sponges, R. E. M. Ortmann, London.
27,413. Velocipede Luggage Carriers, H. G. Turner, Manchester.
27,414. Pincers, F. H. White, Liverpool.
27,415. Windows, O. Hutchison, Edinburgh.
27,416. Rotary Pumps and Air Compressors, M. Hedderwick, jun., Glasgow.
27,417. Softening Feed Water in Boilers, G. E. and J. F. Stead, Leeds.
27,418. Colour Photography, W. N. L. Davidson, Brighton.
27,419. Pencils, J. K. Edwards, Belfast.
27,420. Railway Signalling Apparatus, F. G. Meeds, Gainsborough.
27,421. Pneumatic Tires, T. McC. De Bingham, P. A. E. Wood, and A. G. Brown, Manchester.
27,422. Pure Spray Carburetter, S. J. and E. Fellows, Limited, and A. Nightingale, Wolverhampton.
27,423. Wire Hanger for Incandescent Lighting, A. Marland and H. Warburton, Farnworth, near Bolton, Lancs.
27,424. Magnetising Iron, M. Walker, Manchester.
27,425. Glue and Gelatine, H. Hilbert, Manchester.
27,426. Boot Lining and Loop Covers, D. A. Berry, Northampton.
27,427. Shirt and Collar Fastener, W. Peddie, Glasgow.
27,428. Corrugating Plate Metal, C. A. Embleton, Middlesbrough.
27,429. Spears for Pig Sticking, R. C. Thomson.—(*W. L. Graham, India.*)
27,430. Stocking, D. Macdonald, Manchester.
27,431. Carrying Incandescent Gas Mantles, H. Dewey, Birmingham.
27,432. Lever Toothed Gear, A. de Cholnoki, Germany.
27,433. Working Railway Switch Points, L. W. and O. R. Williams, Glasgow.
27,434. Electric Switches, C. Brown, F. Olaf, and Brown and Barlow, Limited, Birmingham.
27,435. Label Fastener, W. W. Curties and E. R. Smith, London.
27,436. Sash Fastener and Window Holder, A. J. H. Moffat, Glasgow.
27,437. Arc Lamps, G. M. Zingel, W. Wolf, and A. Reiner, London.
27,438. Bearings for Scales, W. E. Hipkin, Birmingham.
27,439. Tintographs, S. J. Riordan, Dublin.
27,440. Grinding Mills, G. Carlson, London.
27,441. Water Level Regulator, E. Hannemann, Berlin, Germany.
27,442. Fly Catchers, W. Dudek, Dresden, Germany.
27,443. Electric Lamps, A. Eckstein and A. E. Angold, Manchester.
27,444. Electric Switches, A. Eckstein and A. J. D. Krause, Manchester.
27,445. Speedometers, H. Davis, London.
27,446. Bogie Driер, A. B. Lennox, Glasgow.
27,447. Coupling Device, N. Norris, Manchester.
27,448. Boiler for Radiators, H. and W. E. Berry, Manchester.
27,449. Electro-static Separation, W. Fairweather. —(*C. H. Huff, United States.*)
27,450. Devices for Developing the Lungs, G. M. Thomson, London.
27,451. Castors, J. Appleby, London.
27,452. Boilers, W. W. Shilling, London.
27,453. Shoots for Loading Vessels, E. Boucher, London.
27,454. Gauntlets, T. Stacey, London.
27,455. Storing and Preserving Furs, V. Honour, London.
27,456. Electro-magnetic Ignition Device, F. Lutz, London.
27,457. Making Tin-plates, R. B. and H. S. Thomas, London.
27,458. Steam Boilers, O. Meredith, Rock Ferry, Cheshire.
27,459. Explosives, L. Lheure, London.
27,460. Explosives, L. Lheure, London.
27,461. Protecting Wrapper for Press Buttons, I. Kleinmann, Berlin, Germany.
27,462. Improved Surface Gauge, T. Greenwood, London.
27,463. Pads for Boots and Shoes, A. T. Woodhead, London.
27,464. Plyers, O. Zerkowitz, London.
27,465 Producing Artificial Light, H. Lüttke, P. Arndt, and E. L. Löwengard, London.
27,466. Producing Artificial Light, H. Lüttke, P. Arndt, and E. L. Löwengard, London.
27,467. Working Traffic on Single Lines of Railway, W. T. Lucy, Oxford.
27,468. Colour Printing, Dalziel Colour Press, Limited.—(*Société Edouard Lambert and Cie., France.*)
27,469. Vehicle Wheels, T. Parker, London.
27,470. Mousing Counterbalanced Hook, W. C. Angove and W. Watkins, Blackwall.

27,471. DECORTICATING FIBROUS STEMS, W. J. Keymer, S. R. Baildon, and T. Burrows, London.
27,472. DETONATORS, G. H. Rayner.—(*F. J. Treyoning, Cape Colony.*)
27,473. PRODUCTION of a COMBUSTIBLE MIXTURE, J. Clay and S. Goodall, London.
27,474. BOXES, W. R. Comings, London.
27,475. ELECTRICAL SWITCHES, W. R. Comings, London.
27,476 WEIGHING MACHINES, C. H. Pollard, London.
27,477. BINDING MAGAZINES, W. E. Richards and G. J. Stevens, London.
27,478. ROLLING SHUTTERS, P. H. Wilson, London.
27,479. INVERTED ARC ELECTRIC LAMP, N. P. Andrew and T. M. M. Johns, London.
27,480. COTTON GINNING APPARATUS, T. H. Pearse, London.
27,481. HAT PIN, E. J. Lewis, London.
27,482 IMPROVED ROTARY ENGINES, G. H. Hartman, London.
27,483. OIL LAMPS, V. J. Morris, London.
27,484. IMPROVED GAME, C. Rudd and J. Carr, London.
27,485. STEAM GENERATORS, R. Aitken, London.
27,486. OBTAINING SAMPLES of SEED, C. H. Bratley and C. W. Hubbard, London.
27,487. BRACES, M. E Richards, London.
27,488 TAPS and VALVES, J. G. Stidder and J. E. Cooper, London.
27,489. NON-SLIPPING HEELS for BOOTS, J. G. Stidder and J. E. Cooper. London.
27,490. INSPECTION CHAMBERS for DRAINS, J. G. Stidder and J. E. Cooper, London.
27,491. RADIATING BLOCK for GAS FIRES, J. G. Stidder J. E. Cooper, London.
27,492. DRAIN STOPPERS, J. G. Stidder and J. E. Cooper, London.
27,493. FLUSHING CISTERNS, J. G. Stidder and J. E. Cooper, London.
27,494. WINDOW CLEANING, J. G. Stidder and J. E. Cooper, London.
27,495. SURFACE DRAIN GULLEYS, J. G. Stidder and J. E. Cooper, London.
27,496. MANUFACTURE of COLOUR LAKES, C. D. Abel.—(*Akt.-Ges. für Anilin Fabrikation, Germany.*)
27,497. MANUFACTURE of ORTHO-NITRO-DERIVATIVES, C. D. Abel.—(*Akt.-Ges. für Anilin Fabrikation, Germany.*)
27,498. MANUFACTURE of PARA-AMIDO-PHENOL-SULPHONIC ACID, C. D. Abel.—(*Akt.-Ges. für Anilin Fabrikation, Germany.*)
27,499. MANUFACTURE of INDOPHENOLS, C. D. Abel.—(*Akt.-Ges. für Anilin Fabrikation, Germany.*)
27,500. APPARATUS for BENDING METAL TUBES, W. Kennedy, London.
27,501. FENCE-MAKING MACHINES, A. J. Boult.—(*C. M. Lamb, United States.*)
27,502. SIGNALLING APPARATUS for RAILWAYS, W. E. Bodycoat, London.
27,503. HEAD LIGHTS for VEHICLES, J. Lafitte, London.
27,504. CONSTRUCTION of SPANNERS, W. Boswell, London.
27,505. PERCUSSIVE APPARATUS, W. Brady and W. C. Spencer, London.
27,506. CHANGE SPEED GEAR, R. J. A. Delacroix, London.
27,507. MUSIC PORTFOLIOS, E. A. Casey and P. W. Ayckbourn, Nunhead.
27,508. CHAIN GEARING, A. Craig, Coventry.
27,509. BRAKE SHOES for VEHICLES, W. W. Morton, London.
27,510. CANDLE MOULDING MACHINE, W. Calderwood, London.
27,511. INNER SOLES for BOOTS and SHOES, T. Holland, London.
27,512. CHANGE SPEED GEAR, G. Green and Lord F. P. C. Hope, London.
27,513. IMPROVED CASEMENT STUDS, A. W. Mills, London.
27,514. STOVES, W. Puff, Liverpool.
27,515. FRAMES of WEAVING LOOMS, H. J. Haddan.—(*F. Jové and J. Sobré, Spain.*)
27,516. METHOD of PRESERVING MILK, C. Jung, London.
27,517. MACHINES for CLEANING BOOTS, C. Russ, London.
27,518. NON-REFILLABLE BOTTLES, A. Sullivan, T. W. Pritchard, and R. W. C. Ellison, London.
27,519. MANUFACTURE of PRODUCER GAS, G. Viarmé, London.
27,520. FIRE-ALARMS, G. H. Oatway, London.
27,521. CRUSHING MILLS, J. C. Wegerif, London.
27,522. SLIDING SASH WINDOWS, W. F. Williams, London.
27,523. DOMESTIC FIRE-ESCAPES, O. O. Jacob, London.
27,524. UTILISING BLAST FURNACE GAS, P. L. Hulin, London.
27,525. DINING BARS for RESTAURANTS, G. C. Nobile, London.
27,526. PRINTING DEVICES, P. T. Hahn, London.
27,527. LININGS for WELLS, F. H. Heise, London.
27,528. APPARATUS for DISTRIBUTING PULVERULENT MATERIAL, G. C. Marks. —(*G. Goldman, United States.*)
27,529. GARMENT PADS, G. C. Marks.—(*G. Goldman, United States.*)
27,530. FINISHING GARMENT PADS, G. C. Marks.—(*G. Goldman, United States.*)
27,531. MACHINE for FINISHING the SURFACES of MATTED MATERIAL, G. C. Marks.—(*G. Goldman, United States.*)
27,532. MOISTURE-CARRYING BELTS, G. C. Marks.—(*G. Goldman, United States.*)
27,533. TREATING FIBROUS MATERIALS, G. C. Marks.—(*G. Goldman, United States.*)
27,534. SKIVING MACHINES, G. C. Marks.—(*G. Goldman, United States.*)
27,535. CUTTING GARMENT PADS, G. C. Marks.—(*G. Goldman, United States.*)
27,536. FOLDED SHEETS of PAPER, W. J. Alcock.—(*S. Wheeler, United States.*)
27,537. VAPOUR ELECTRIC APPARATUS, H. I. Wood, London.
27,538. TRANSFORMING ELECTRIC CURRENT, C. P. Steinmetz, London.
27,539. ROTARY ENGINES, J. Woodside, London.
27,540. BRUSHES with REVERSIBLE HANDLE, G. F. Jahn, London.
27,541. BALL-JOINT COMPENSATORS for STEAM PIPES, F. Seiffert, London.
27,542. PNEUMATIC PLAYING MECHANISM for PIANOS, C. E. Trimble, London.
27,543. TYPEWRITING MACHINES, R. W. James.—(*The Union Typewriter Company, United States.*)

17*th December*, 1904.

27,544. AUTOMATIC SAFETY MINERAL OIL LAMP, F. Davis and F. Jinks, Swindon.
27,545. AUTOMATIC FIRE ALARM, G. F. Allom, Northwood, Middlesex.
27,546. REVERSIBLE and RAIN-PROOFED GARMENTS, W. G. Hewlett, Dorchester.
27,547. RECORDING SPEED INDICATORS, F. Knoeferl and H. M. Salmony, London.
27,548. ADMINISTERING of ETHYL CHLORIDE, P. B. Hutchinson, Brentwood, Essex.
27,549. ADJUSTABLE TABLE SHELF, A. E. Rickaby and J. N. Davis, Plymouth.
27,550. RAILWAY TICKET HOLDER, C. M. P. H. Triscott, Dublin.
27,551. PNEUMATIC TIRE, B. H. Trippe, Bristol.
27,552. POLISHING or BURNISHING BARRELS, G. Lewis, Birmingham.
27,553. PNEUMATIC TIRES, H. N. Grove, Wolverhampton.
27,554. PAINTING BOOKS, H. J. Valentine, Dundee.
27,555. SAWS, S. B. Halcomb, P. MacGregor, and A. Taylor, Sheffield.
27,556. PATCHING FABRIC for PNEUMATIC TIRES, H. Guest, Sheffield.
27,557. DOOR LATCH, A. Steadman, Wigan.
27,558. SCHOOL DESKS, J. Millward and J. Wheeldon, Huddersfield.
27,559. GEAR for BORING TAPERING HOLES, G. Halliday and J. McPherson, Glasgow.
27,560. ADVERTISING, S. L. Galloway and H. Akeroyd, Bradford.
27,561. PULLEY BLOCKS, J. Holt, Birmingham.
27,562. COMBINED CURTAIN RING and HOOK, J. Burns Birmingham.
27,563. HOLDING APPLIANCE for PIT CAGES, W. H. Becker and R. F. Williams, Bristol.
27,564. FOLDING CHAIRS, H. F. Cook, Kingston-on-Thames.
27,565. MANUFACTURE of ARTIFICIAL SILK, L. Crespin, Manchester.
27,566. HAULAGE CLIP for ENDLESS ROPES, J. A. Burchall, Earlestown, Lancs.
27,567. STEAM VALVES, F. Shaw, Halifax.
27,568. DRAWING INSTRUMENT, W. and F. L. Dargue, Halifax.
27,569. COLLAPSIBLE BOXES, A. A. Brown, Glasgow.
27,570. CRUCIBLE FURNACES, A. Smallwood, Birmingham.
27,571. GAS PRODUCERS, E. Hall-Brown, Glasgow.
27,572. STEAM GENERATORS, J. Gresty, Levenshulme, Lancs.
27,573. FOLDING BOX, A. E. Terry, Birmingham.
27,574. LOCKS, J. and J. B. Goodare, Wednesfield.
27,575. RACING TRAP, H. E. Jackson and W. Pimlott, Manchester.
27,576. AUTOMATIC GAS LIGHTERS, J. Rosie, Rathdowney, Queen's Co., Ireland.
27,577. SORTING MACHINE, F. Stacey and C. A. Cooke, Birmingham.
27,578. PNEUMATIC TIRES, A. P. Adams and F. W. Sydenham, Birmingham.
27 579. CONCENTRATING LIQUIDS, F. Wertenbruch, Nottingham.
27,580. WEIGHTLESS SASH MANIPULATOR, W. Cowley, Cheltenham.
27,581. TELESCOPIC SIGHTS for ORDNANCE, A. König, Jena, Germany.
27,582. CONDUITS for ELECTRIC CABLES, H. R. Mansfield, Coalville, near Leicester.
27,583 CUSHIONS for BILLIARD TABLES, D R. and F. W. Padmore, Birmingham.
27,584. CONSTRUCTING FOUNDATION WORKS, F. Kirk, London.
27,585. DOOR LOCKS, T. Leach, Manchester.
27,586. FURNACES for INFERIOR FUEL, J. E. Slack, Reddish.
27,587. SAND-MOULDING MACHINES, J. D. Duckett and A. W. Steven, London.
27,588. SEALING CUPS for AIR TUBE of PNEUMATIC TIRE, W. G. Woodcock, Leicester.
27,589. ARTIFICIAL LIGHT for PHOTOGRAPHY, G. W. Morgan, Aberdeen.
27,590. CONSTRUCTION of PLOUGHS, W. Bisset, Huntly, Aberdeenshire.
27,591. DECORATION of PLATE GLASS, O. C. Hawkes, London.
27,592. MANIFOLD CHECK DEVICES, W. S. Brewer, London.
27,593. TELESCOPE STAND, W. Simms, London.
27,594. PUNCH for PAPERS, H. P. Lavender, London.
27,595. AUTOMATIC WEIGHING MACHINES, M. Graham, London.
27,596. OBTAINING PURE ANTHRACENE from CRUDE ANTHRACENE, V. Vesely and E. Votocek, London.
27,597. ANIMAL FOOD, F. Livingstone, London.
27,598. FIREGUARDS, E. Westergren, Liverpool.
27,599. RAISING SUNKEN VESSELS, F. G. Nielsen, Liverpool.
27,600. MANUFACTURE of WIRE GLASS, A. C. Pilkington, Liverpool.
27,601. SHEET REGISTERING DEVICES for PLATEN PRINTING PRESSES, E. L. Megill, Liverpool.
27,602. ABRADING SHOES for TRUEING-UP CAR WHEELS, J. M. Griffin, Liverpool.
27,603. VULCANISING APPARATUS, H. H. Frost, London.
27,604. WEAVING LOOMS, E. Graf, London.
27,605. ELECTRICALLY-DRIVEN VEHICLES, E. E. Lehwess, London.
27,606. CHAIN HOOKS and LINKS, L. D. Mattassi, London.
27,607. OUTDOOR GAS LAMPS, T. S. Haight, London.
27,608. MEASURING and DISCHARGING LIQUIDS, O. A Elias, London.
27,609. DETACHABLE DEVICE for BURNERS of CENTRAL DRAUGHT LAMPS, E. E. Wagstaff, London.
27,610. DETACHABLE DEVICE for BURNERS of FLAT WICK LAMPS, E. E. Wagstaff, London.
27,611. DETACHABLE THIMBLE for ROUND BURNER LAMPS, E. E. Wagstaff, London.
27,612. RELIEF VALVES, G. O. H. Klopp, London.
27,613. NON-REFILLABLE BOTTLE, J. Weller, London.
27,614. EXTINGUISHING GAS LIGHT APPARATUS, M. W. Haenke, London.
27,615. VEHICLE WHEELS, P. Parik, London.
27,616. TYPEWRITERS, M. Soblik, London.
27,617. BINDING MECHANISM of HARVESTING MACHINES, S. Day, T. Day, jun., T. Day, sen., and F. Day, London.
27,618. ATOMISING FLUIDS, C. F. de Kierzkowski-Steuart, London.
27,619. MAKING METAL CASTINGS, G. K. B. Elphinstone, London.
27,620. CARDBOARD BOXES, P. M. Robinson, London.
27,621. CONTRIVANCE for FORMING a RESERVOIR for STERILISED WATER, The Compagnie Française de l'Ozone, London.
27,622. TOOTH-BRUSHES, J. G. Warren, London.
27,623. HAIR PINS, F. Gill and J. de Boer, London.
27,624. TOILET "TIDIES" and like RECEPTACLES, F. Bell, London.
27,625. BRAIDING MACHINES, A. Arthmann, London.
27,626. PRESERVING YEAST, H. Livingstone, London.
27,627. PORTABLE ELECTRIC CONDUCTORS, A. Bergthell, London.
27,628. METAL CAPS for JARS, F. W. Feaver, London.
27,629. LOCKS for HOLDING MILK CANS, C. A. Imms, London.
27,630. WINDOW SASHES, F. J. and H. G. Carl, London.
27,631. PNEUMATIC TIRES, P. Magnus, London.
27,632. UTILISING WASTE HEAT of FURNACE GASES, H. L. Davies, London.
27,633. CLEANING KNIVES, J. S. Stewart-Wallace, London.
27,634. ASHBINS, J. H. Chidester, London.
27,635. PREPARING PRESERVES, H. H. Lake.—(*J. Ephraim, Germany.*)
27,636. LIGHTING SYSTEMS, The Allgemeine Elektricitäts-Gesellschaft, London.
27,637. VAPOUR ELECTRIC APPARATUS, J. T. H. Dempster, London.

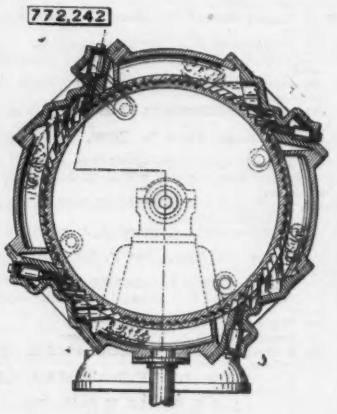
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

772,242. TURBINE, *A. M. Levin, Joliet, Ill.—Filed February 1st*, 1904.

Claim.—A multiple-impulse turbine comprising a wheel having a row of buckets, an expansion nozzle delivering into said buckets and a stationary reversing

772,242

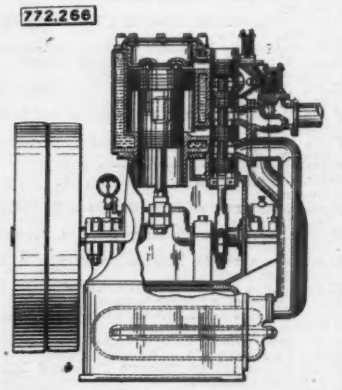


guide extending from said nozzle over a number of said buckets to form a space open from end to end within which the steam or other motive fluid proceeds in a helical whirl and is successively projected against the buckets of said wheel.

772,266. AIR COMPRESSOR, *S. E. Alley, Glasgow, Scotland.—Filed January 27th*, 1904.

Claim.—In a "stage" gas compressor the combination of a differential trunk reciprocating piston, a cylinder divided by it into two compression chambers, an inlet conduit and an exhaust conduit appropriated to and terminating in each of the two compression chambers, sliding valves adapted to open and close both conduits of each compression chamber, a valve operating mechanism by which the sliding valves are given simple harmonic motion across the conduits, two fluid-operated valves each controlling one of the

772,266

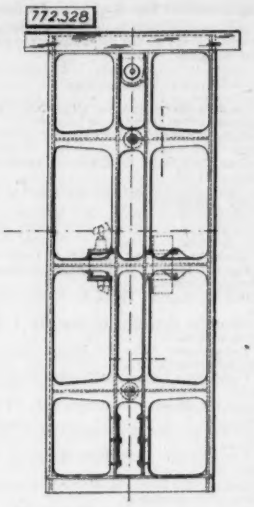


exhaust conduits, and situated at a point therein, which is farther from the cylinder than are the sliding valves, a loading spring applied to each of the fluid-operated valves tending to keep each valve always in a position in which it closes the conduit, and so proportioned as to apply to the valve a thrust greater than that which, immediately that the sliding valves open the exhaust conduit is exerted upon it in such a direction as to tend to open it by the air in compression in that portion of the exhaust conduit which is between the loaded fluid-operated valve and the piston.

772,328. LOCOMOTIVE TENDER FRAME, *T. E. Adams, Pine Bluff, Ark.—Filed August 1st*, 1904.

Claim.—A locomotive tender frame made in two parts, each part comprising two side and end pieces respectively, and a cross-piece intermediate and parallel to the end pieces, the said cross piece forming the tender body bolster, and having the body

772,328

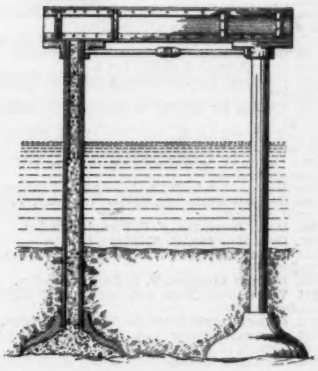


centre-plate integral therewith on its under side, and perforated for the king-bolt, all the said pieces being integral throughout, and means for fixing the said parts together, substantially as described.

772,615. BRIDGE PIER, *B. F. Hudson, Oklahoma, Okla.—Filed August 27th*, 1901.

Claim.—(1) A bridge pier comprising a hollow shaft, a hollow bell-shaped anchoring base connected with the lower end of the shaft for supporting it, and an annular internally-arranged shoulder for supporting the lower end of the shaft upon the bell, the flaring

772,615

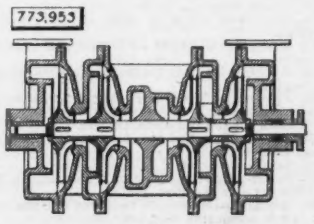


lower portion of the bell forming a broad anchoring support for the pier. (2) A bridge pier comprising a cylindrical shaft, a diverging removable base secured to said shaft, a cylindrical cushion retained within the upper portion of said shaft, and a filling retained within said cushion and shaft.

773,953. POLYCELLULAR CENTRIFUGAL PUMP, *A. Maginot, Dampierre, France.—Filed April 14th*, 1904.

Claim.—A polycellular centrifugal pump, having a plurality of stationary forcing shells, an axially-disposed shaft, and turbines on said shaft within the chambers of the respective shells, each intermediate shell having in its chamber a partition of spiraloid

773,953



form which divides the chamber into two concentric spiraloid channels, one channel serving as a forcing collector and the other as a suction volute, the two channels being connected at the point where their sections are largest, and said pump having shells each with a passage of spiraloid form and provided respectively with the inlet and an outlet for the fluid.

END OF VOL. XCVIII.

The Engineer.

Registered as a Newspaper

OFFICE FOR ADVERTISEMENTS AND PUBLICATION, 33, NORFOLK STREET, STRAND, W.C.

VOL. XCVIII.—No. 2557] LONDON: FRIDAY EVENING, DECEMBER 30, 1904. [PRICE {WITH SUPPLEMENT} SIXPENCE

Engineer Cadets in the NAVY (14)-14)).—FORTHCOMING EXAMINATION, 15th FEBRUARY, 1905. The date specified is the latest at which applications can be received.

They must be made on forms to be obtained, with particulars from the SECRETARY, Civil Service Commission, Burlington-gardens, London, W. 1734

OFFICIAL NOTICE.
SALE OF OLD IRON (Anchors and Chains).

The Board of Trade are

prepared to receive TENDERS for the PURCHASE of about 88 TONS of OLD IRON (Anchors and Chains), now in the custody of the Receivers of Wreck for the undermentioned districts, viz.:—

Yarmouth	about 21 tons.
Lowestoft	about 32 tons.
Hull	about 22 tons.
London	about 13 tons.

The exact places where the anchors and chains can be inspected may be ascertained upon application to the Receivers of Wreck at the above-mentioned ports, who will, upon application, and payment of the cost of copying, supply lists, giving particulars of the various lots.

If a Tender is made for lots at more than one port a separate price should be stated for each port.

The weights specified must be accepted, but if a tenderer requires a lot to be re-weighed this can be done at his expense.

All lots for which Tenders are accepted must be cleared within a month from the date of acceptance.

Tenders should be sent in to the Harbour Department, Board of Trade, London, S.W., by noon on the 9th day of January, 1905, addressed to the Assistant Secretary, and marked outside, "Tenders for Old Iron (Anchors and Chains)."

No particular form of Tender is necessary.

The Board of Trade do not bind themselves to accept the highest or any Tender.

T. H. W. PELHAM,
Assistant Secretary.

Board of Trade, Harbour Department,
19th December, 1904. 1739

The Chief Superintendent,

ROYAL ORDNANCE FACTORIES, WOOLWICH (from whom all particulars may be obtained on application) is prepared to receive APPLICATIONS for SEVERAL APPOINTMENTS to be made January, 1905, of :—

I.—SUPERVISORS. Salary, £150 to £220 per annum.
II.—WORKSHOP STUDENTS. 20s. to 30s. per week.

Candidates for both must have a degree or diploma obtained after a three years' course at an approved engineering college.

Candidates for I. must have had practical workshop training.

Candidates for II. will receive a three years' course of workshop training under favourable circumstances. 1708

New Conveyor Company, Ltd.,

SMETHWICK, BIRMINGHAM.

The ATTENTION of the Directors of the New Conveyor Company, Limited, has been CALLED to certain LETTERS and CIRCULARS recently ISSUED by Mr. GILBERT LITTLE, late chairman and managing director of the Company, but now holding no official position in the Company

Mr. Gilbert Little has made a wholly unauthorised use of the letter paper and the name of the Company, and the Company has been compelled to take proceedings in the Chancery Division against Mr. Little, and to obtain the perpetual injunction against him set out below. To prevent misunderstanding the Board desire us to point out the following facts:—

1. The New Conveyor Company, Limited, has no connection whatever with any other Company formed or to be formed by Mr. Gilbert Little.
2. Mr. Gilbert Little and his sons are not now either officially connected with or in the employ of the New Conveyor Company, Limited.
3. The New Conveyor Company, Limited, has not parted with any of its patent rights and the patents under which so many conveyors and elevators have been erected by the Company remain, by arrangement vested in the Company, and conveyors and elevators in accordance with these patents can only be supplied by the Company.

1904, N. No. 1752.

IN THE HIGH COURT OF JUSTICE,
Chancery Division,
Mr. Justice Kekewich.
Mr. R. H. W. Leach,
Regr.
Friday the 16th day of December, 1904.

BETWEEN THE NEW CONVEYOR COMPANY, LIMITED, Plaintiffs, and

GILBERT LITTLE, Defendant.

UPON MOTION for an injunction this day made unto this Court by Counsel for the Defendant and the Plaintiff by their Counsel consenting to treat the hearing of the said Motion as the trial of this Action and consenting to this Judgment THIS COURT DOTH ORDER AND ADJUDGE that the Defendant Gilbert Little be perpetually restrained from using the notepaper of the Plaintiffs or any colourable imitation thereof or any notepaper or envelopes marked with the Plaintiffs' name apart from issuing any circular or writing in the name of the Plaintiffs and from representing the Defendant as being Chairman and Managing Director or otherwise employed by or as holding any office in the Plaintiff Company and from using the name of the Plaintiffs so or in such manner as to represent or suggest that the Defendant is carrying on or assisting in carrying on or interested (otherwise than a Shareholder) in the Plaintiff Company And the Plaintiffs waiving any enquiry as to damages THIS COURT DOTH ORDER that the Defendant Gilbert Little do pay to the Plaintiffs their costs of and incidental to this Action as between them and their Solicitors and including therein any costs incurred prior to the Writ of Summons (such costs to be taxed by the Taxing Master).

NEW CONVEYOR CO., LTD.
W. T. HOLLAND,
Secretary.

Smethwick, December 27th, 1904. 1765

Crystal Palace Company's School

OF PRACTICAL ENGINEERING. Principal, J. W. Wilson, M. Inst. C.E., M.I. Mech. E. The FIRST TERM of the 33rd Year will OPEN on THURSDAY, JANUARY 5th. New students should present themselves at the School on the previous day, between 10 a.m. and 1 p.m., for examination. —Prospectus forwarded on application to the SECRETARY of the Crystal Palace Company, Crystal Palace, S.E. 1757

Coventry Engineering Society

REQUIRES LECTURER for February 3rd. Topic, "Modern Drawing-office Requirements." Discussion and travelling expenses guaranteed.—Hon. Sec., H. W. JACKSON, 19, Cope-street. P557

County Borough of Hudders-

FIELD TECHNICAL COLLEGE.

Principal: J. F. HUDSON, M.A., B.Sc.

APPLICATIONS are invited for the POST of ASSISTANT LECTURER in the DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING.

Candidates must have had workshop and drawing-office training. Salary, £130.

Further particulars can be obtained from
THOMAS THORP,
Secretary.

1756

King's College, London

(UNIVERSITY OF LONDON).

FACULTY OF ENGINEERING AND APPLIED SCIENCE.

LENT TERM COMMENCES MONDAY, JANUARY 9TH.

PROFESSORS:

ENGINEERING—DAVID S. CAPPER, M.A., M. Inst. C.E., M.I.M.E.; H. M. WAITHMAN, A.M.Inst.C.E., A.M.I.M.E.; M. CURRY, M. Inst. C.E.
ELECTRICAL ENGINEERING—E. WILSON, M.I.E.E.
NATURAL PHILOSOPHY—W. G. ADAMS, M.A., D.Sc., F.R.S.; H. A. WILSON, M.A., D.Sc.; S. C. LAWS, B.A., B.Sc.
BUILDING CONSTRUCTION—B. ELSEY SMITH, A.R.I.B.A.
CHEMISTRY—J. M. THOMSON, F.R.S., F.I.C.; H. JACKSON, F.I.C.
MATHEMATICS—S. A. F. WHITE, M.A.; T. B. DALE, M.A.
METALLURGY—A. K. HUNTINGTON, A.R.S.M., M.I.M.E.
GEOLOGY and MINERALOGY—H. G. SEELEY, F.R.S.

EVENING CLASSES are held for Civil, Mechanical, and Electrical Engineering, Workshop Practice, Architecture, and Building Construction, Drawing, Metallurgy, Mathematics, Physics, and all Science Subjects.

ADVANCED EVENING CLASSES.—Civil Engineering, Mechanical Engineering, Electrical Engineering.

For prospectuses and all information apply to
THE SECRETARY,
King's College, Strand, W.C. 1772

Northampton Institute, St.

JOHN-STREET-ROAD, E.C.

The Governing Body INVITE APPLICATIONS for the POST of CHIEF ASSISTANT in the Mechanical Engineering Department, rendered vacant by the appointment of Mr. W. E. Curnock to be Head of the Engineering Department at the Technical College, Huddersfield.

The appointment is a full time appointment for day and evening work.

Salary £180 per annum.

For further particulars and forms of application, which should be returned not later than 10 a.m. on Tuesday, 3rd January, 1905, apply to

R. MULLINEUX WALMSLEY, D.Sc.,
Principal.

1640

The Victoria University of

MANCHESTER.

The Council desires to proceed to the APPOINTMENT of a PROFESSOR of ENGINEERING.

The Professor will be responsible for the organisation of the Engineering Department, and will have the direction of the Engineering Laboratory.

He may take a consulting practice under specified conditions.

His stipend will be composed of a fixed salary and a share of the fees, and the Council guarantee that the total income will not be less than £1000 per annum during the first three years.

A detailed statement of the conditions of appointment may be obtained from the Registrar.

Applications, with references and such testimonials (not exceeding three in number) as the candidate may desire, should be sent on or before February 15th to the REGISTRAR. 1645

Board of Public Works.—Notice

TO CONTRACTORS.

Sealed TENDERS, addressed to the undersigned, will be received up to, but not later than, Ten o'clock a.m. on the 11th day of February, 1905, for EXECUTING certain WORKS at Downies Bay, County Donegal, viz.:—An EXTENSION of the existing PIER, DREDGING, ROCK EXCAVATION, &c., according to the plans to be seen at the Coastguard Station, Muiroy, Largaurcagh, Letterkenny, County Donegal, and at this office, where the specification, schedule, form of contract, and printed form of Tender can be had.

The Board will not be bound to accept the lowest or any Tender.

By order,
H. WILLIAMS,
Secretary.

Office of Public Works, Dublin,
22nd December, 1904. 1743

Borough of Dover.—Light Rail-

WAY.

The Town Council invite TENDERS for the CONSTRUCTION of about 1¼ MILES of DOUBLE LINE of LIGHT RAILWAY to River, commencing by a junction with the Dover Corporation Tramways at Buckland, including the SUPPLYING and LAYING of STEEL GIRDER RAILS, FISH-PLATES, TIE BARS, &c., GUERNEY GRANITE SETTS, and JARRAH WOOD PAVING BLOCKS on a bed of Cement Concrete; also CREOSOTED DEAL SLEEPERS, &c., STEEL POLES, and OVERHEAD EQUIPMENT, COPPER BONDS, &c., in One Contract.

A form of Tender, specification, and bill of quantities, may be obtained on payment of Five Guineas (returnable on receipt of a bona fide Tender if the Tender is not accepted) and conditions and plans inspected at the Office of the Borough Engineer, Maison Dieu House, Dover, on and after 3rd January, 1905, during office hours.

Tenders, endorsed "Tender for Light Railway," to be sent to me on or before noon on Monday, the 16th January, 1905.

The Council do not bind themselves to accept the lowest or any Tender.

WOLLASTON KNOCKER,
Town Clerk.

Town Clerk's Office, Castle Hill House,
Dover, 26th December, 1904. 1745

Borough of Swindon.—Electricity

AND TRAMWAYS DEPARTMENT.

LANCASHIRE BOILER, &c.

The Corporation of Swindon invite TENDERS for the SUPPLY and ERECTION of ONE 30ft. × 8ft. LANCASHIRE BOILER, with downtake superheater, steam, exhaust, and feed piping, &c.

Copies of the general conditions, specification, and forms of Tender may be obtained on application to the Engineer and Manager, Mr. J. G. Griffin, A.M.I.E.E., Electricity Works, Swindon, on payment of a deposit of One Guinea for each copy, which will be returned on receipt of a bona fide Tender.

Extra copies may be obtained at 5s. each.

The firm whose Tender is accepted will be required to find two responsible sureties, and to enter into a contract to be prepared by and to contain such clauses as the Town Clerk may deem necessary.

Tenders on the prescribed form, and accompanied by the specification and general conditions intact, and endorsed "Tender for Lancashire Boiler," to be delivered to the undersigned before 10 a.m. on Tuesday, January the 24th next.

The Corporation do not bind themselves to accept the lowest or any Tender.

By order,
ROBERT HILTON,
Town Clerk.

Town Hall, Swindon,
23rd December, 1904. 1746

District Lunatic Asylum,

KILLARNEY.

LAUNDRY MACHINERY REQUIRED.

ESTIMATES will be received for the SUPPLY of a LAUNDRY ENGINE and HYDRO-EXTRACTOR up to 10th January, 1905.

Specification can be seen at the Asylum, and any information required can be had from the Resident Medical Superintendent.

L. T. GRIFFIN,
Resident Medical Superintendent.

15th December, 1904 1742

Bury and District Waterworks.

TENDERS FOR CAST IRON PIPES, &c.

The Bury and District Joint Water Board invite TENDERS for CAST IRON PIPES and SPECIAL CASTINGS required under the following Contracts:—

PIPE LINE FROM GIN HALL RESERVOIR TO WHITEFIELD.

CONTRACT No. 1.

Providing and delivering at Bury and Whitefield sidings of the Lancashire and Yorkshire Railway Company, 1320 tons of 12in. diameter cast iron pipes and 50 tons of special castings.

SCOUT MOOR HIGH LEVEL RESERVOIR.

CONTRACT No. 2.

Providing and delivering at Ramsbottom and Cloughfold sidings of the Lancashire and Yorkshire Railway Company, 560 tons of 4in., 6in., 8in., and 15in. diameter cast iron pipes, and 30 tons of special castings.

OGDEN RESERVOIR.

CONTRACT No. 4.

Providing and delivering at Ramsbottom and Bury sidings of the Lancashire and Yorkshire Railway Company, 940 tons of 15in. diameter cast iron pipes, and 40 tons of special castings.

Plans may be seen and copies of the specifications, bills of quantities, and forms of Tender obtained at the Bury Office of the Engineer to the Board, Mr. J. Cartwright, Civil Engineer, Peel-chambers, Bury, and 29, Old Queen-street, Westminster, S.W., on and after the 27th instant, upon payment of £1 for each contract.

These sums of deposit will, after the Committee shall have come to a decision upon the Tenders, but not before, be returned to the tenderers, provided they shall have sent in a bona fide Tender, and shall not have withdrawn the same, and shall have returned all documents furnished to them for the purpose of making up their Tender.

Tenders, enclosed in the official envelopes provided, must be delivered at the office of the subscriber not later than Saturday, the 7th January, 1905.

JOHN HASLAM,
Clerk to the Board.

Bank-street, Bury,
22nd December, 1904. 1749

County of London.—The London

COUNTY COUNCIL (NORTHERN) TRAMWAYS.

TO ENGINEERS, CONTRACTORS, AND OTHERS.

The London County Council invites TENDERS for the ROADWORK and PLATE-LAYING required for the Construction, for electrical traction on the conduit system, of the authorised Tramway in Rosebery-avenue, and of a portion of the authorised Tramway in St. John-street-road, in the Metropolitan Boroughs of Holborn and Finsbury.

The total length of the above-mentioned lines is equivalent to about 1¼ miles of single track.

The contractor will be required to use the track rails with their fastenings and the slot rails, which will be furnished by the Council under another contract; but all the remaining metal work and other materials, and all the special work at junctions, crossings, crossovers, &c., will be included in the contract.

Persons desiring to submit Tenders may, on and after Friday, 30th December, 1904, obtain the drawings, specification, form of Tender, and other particulars on application to the Council's Chief Engineer, at the County Hall, Spring-gardens, S.W., upon the payment to the Cashier of the Council of the sum of Five Pounds. This amount will, after the Council or its Committee shall have come to a decision upon the Tenders received, but not before, be returned to the tenderer, provided he shall have sent in a bona fide Tender and shall not have withdrawn the same, but in no case will the fee be returned unless a bona fide Tender is submitted.

Full particulars of the work may be obtained on application at the County Hall, previously to the payment of the fee for the specification, &c.

Tenders must be upon the official forms, and the printed instructions contained therein must be strictly complied with.

The contractors will be bound by the contract to pay to all workmen (except a reasonable number of legally bound apprentices) employed by them wages at rates not less and to observe hours of labour not greater than the rates and hours set out in the Council's list, and such rates of wages and hours of labour will be inserted in and form part of the contract by way of schedule.

Each Tender is to be delivered at the County Hall, in a sealed cover, addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Roadwork and Plate-laying—L.C.C. Tramways."

No Tender will be received after 10 o'clock a.m. on Tuesday, the 24th January, 1905.

Any Tender which does not comply with the printed instructions for Tender may be rejected.

The Council does not bind itself to accept the lowest or any Tender, and it will not accept the Tender of any person or firm who shall on any previous occasion have withdrawn a Tender after the same had been opened, unless the reasons for the withdrawal were satisfactory to the Council.

G. L. GOMME,
Clerk of the London County Council.

County Hall, Spring-gardens, S.W.,
28th December, 1904. 1756

Monmouthshire County Council.

ROADWAY BRIDGE OVER THE RIVER USK AT KEMEYS.

The above Council are prepared to receive TENDERS for the CONSTRUCTION and ERECTION of a STEEL-ARCHED SUSPENSION ROADWAY BRIDGE over the River Usk at Kemeys, on the site of the existing chain bridge.

Plans can be seen either at the office of the County Surveyor, Newport, Monmouthshire, or at the office of Mr. John J. Webster, M. Inst. C.E., 39, Victoria-street, Westminster, the Engineer for the Works, on and after the 5th January, when copies of the specification, form of Tender, and bill of quantities can be obtained upon payment of the sum of three guineas, which will be returned upon the receipt of a bona fide Tender, and the return of all documents.

Sealed Tenders are to be sent to me not later than Ten o'clock on the morning of the 19th January, 1905, and endorsed "Kemeys Bridge."

The Council do not undertake to accept either the lowest or any Tender.

H. STAFFORD GUSTARD,
Clerk to the Council.

County Council Offices,
Newport, Monmouthshire. 1748

The Great Indian Peninsula

RAILWAY COMPANY.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely :—

Axles.	Brushes.
Brass and Iron Screws and Split Pins.	Brass Sheets and Copper Pipes.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

Tenders must be delivered in sealed envelopes, addressed to the undersigned, marked "Tender for Axles," or as the case may be, not later than 11 o'clock a.m. on Thursday, the 12th January, proximo.

The Directors do not bind themselves to accept the lowest or any Tender.

J. I. BERRY,
Secretary.

Company's Offices,
48, Copthall-avenue, E.C.,
London, 26th December, 1904. 1777

For Bradford Corporation Elec-

TRICITY DEPARTMENT.—WANTED IMMEDIATELY, a DRAUGHTSMAN, thoroughly acquainted with the design of heavy Low-tension Switch Gear, and capable of preparing detailed working drawings of same, and for general electricity works draughtsmanship. Not less than twelve months' work to a satisfactory man.—Apply, by letter only, stating age, wages required, and when prepared to start, enclosing testimonials, to ENGINEER and MANAGER, Electricity Offices, Victoria-square, Bradford. 1769

Competent Designer, with Ex-

PERIENCE in Self-propelled Vehicles (steam). Good salary to suitable man.—Address, stating age, experience, salary required, P527, Engineer Office, 33, Norfolk-street, Strand, W.C. P527

Engineer Wanted for Zanzibar,

to Build Locomotives shipped in parts; also to Superintendent Locomotive Shop, and keep all rolling stock in good working order. One with a knowledge of Turning preferred, and competent to take charge of an engine and boiler; also able to run dynamo and keep same in order. Age between 25 and 35. Salary £20 a month, to commence on arrival and end on termination of agreement. Second-class passage out and home.—Apply, stating experience, with copies of testimonials, to ENGINEER, care of Abbott's, 32, Eastcheap, London, E.C. P547

Oil Engines.—Wanted,

thoroughly competent MAN to undertake Design and Superintend the Manufacture of Engines for crude and other oils.—State age, experience, and salary required to 1763, Engineer Office, 33, Norfolk-street, Strand, W.C. 1763

Steam Engines.—Wanted, a

really first-class DESIGNER for Engines of the highest class, with Drop Valves, Trip and Positive Types, able to fix and guarantee competitive steam consumptions.—State age, experience, and salary required to 1764, Engineer Office, 33, Norfolk-street, Strand, W.C. 1764

Wanted, First-class Rolling

STOCK DRAUGHTSMAN used to tramcars, steel carriages, underframes, &c.—State age, experience, and salary required, to F. I. T., at Hornecastle's, Cheapside, E.C. 1706

Draughtsman.—Wanted, for

Engineer's Office, an energetic YOUNG MAN, having had shop experience, accustomed to Calculations; experience in Heating and Ventilation an advantage.—Apply in writing, with full particulars, 1752, Engineer Office, 33, Norfolk-street, Strand, W.C. 1752

Draughtsman Wanted, for Works

near London, used to Jigs and Tools for accurate work.—Address, stating age, experience, and salary required, 1767, Engineer Office, 33, Norfolk-street, Strand, W.C. 1767

Smart Junior Draughtsman Re-

QUIRED, well up in Colliery Surface Plant.—Apply, LOWCA ENGINEERING COMPANY, Limited, Whitehaven, stating age, salary, and experience. 1771

Wanted, Foreman Moulder,

thoroughly conversant with modern methods, mixing of metals, and accustomed to high-class economical production; good disciplinarian. State age, experience, and wage.—Address, P548, Engineer Office, 33, Norfolk-street, Strand, W.C. P548

Required, for London, a Com-

PETENT SHOP FOREMAN for Fitters, Turners, and Smiths; must be accustomed to Contractors' Plant and Machinery and General Smiths' Work.—Address, giving particulars of age, experience, and wages required, 1762, Engineer Office, 33, Norfolk-street, Strand, W.C. 1762

Wanted, by Large Firm in the

iron and steel trade, first-class MAN to TRAVEL in India, China, Japan, and South America. Must be between 30 and 40 years of age; have perfect knowledge of Spanish; well educated and of good address; must have travelled in above countries. Photograph with application, and full particulars and references. Salary about £1000, and all expenses paid. No application will be considered unless it complies with above conditions.—Address, P535, Engineer Office, 33, Norfolk-street, Strand, W.C. P535

Required by a Leading Sheffield

Firm, capable, energetic REPRESENTATIVE for Lancashire and Midlands; a knowledge of steel is desirable; experience an advantage; unexceptional references essential; full details of terms required, age, experience, &c.—Address, 1732, Engineer Office, 33, Norfolk-street, Strand, W.C. 1732

Wanted for Engineer's Office, a

competent COST-CLERK; one acquainted with the Premium and Card Systems preferred.—Apply in writing, stating experience, age, and salary required, 1753, Engineer Office, 33, Norfolk-street, Strand, W.C. 1753

Junior Clerk Wanted for Cost

Department of Engineer's Office; age about 17; must be quick at figures and used to the work.—Address, P555, Engineer Office, 33, Norfolk-street, Strand, W.C. P555

Wanted, by an Old-established

London General Engineering Works, a good all-round GENERAL FITTER, with Electrical Knowledge, a permanency to a suitable man. Age must not be over 35.—Send full particulars, by letter only, of experience, especially of electrical knowledge, to ARNOLD GOODWIN and SON, Ltd., Sumner-street, Southwark Bridge, S.E. 1766

Wanted, Charge Man Over about

20 medium-sized Lathes and Machines; well up in speeds, feeds, and piecework; state age, references, and wages; must have held similar post.—Address, 1723, Engineer Office, 33, Norfolk-street, Strand, W.C. 1723

Wanted, Toolmaker for Drilling

Jigs and Milling Fixtures; light work. None but quick, accurate workmen need apply; good wages.—Reply, detailing experience, to P543, Engineer Office, 33, Norfolk-street, Strand, W.C. P543

Wanted, Toolmaker, for Taps,

Dies, small Capstan and Automatic Tools. Must be accustomed to setting up, and must be able to produce accurate work quickly. Good wages to suitable man.—Reply, with full particulars as to experience, to P544, Engineer Office, 33, Norfolk-street, Strand, W.C. P544

For continuation of Small Advertisements see pages II., III., IV., *and* LXVI.

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Wanted, Turner for Tool Room. One accustomed to a light Precision Lathe; must be a quick, accurate man; good wages paid.—Full particulars to P545, Engineer Office, 33, Norfolk-street, Strand, W.C. P545

A.M. Inst. C.E., B.A. (Cantab), mathematical scholar, 28, DESIRES RESPONSIBLE POST as RESIDENT ENGINEER or OTHERWISE; large experience in reservoirs, concrete aqueducts, pipe laying, pumping stations, also bacteriological sewage purification; good draughtsman, proficient in use of theodolite, level, &c.; calculations a speciality; testimonials.—Address, P539, Engineer Office, 33, Norfolk-street, Strand, W.C. P539

A M.I.M.E., Public School Man, with twelve years' experience (five in shops) with leading firms, WANTS BERTH as MANAGER'S ASSISTANT, charge of Erection or Running of Plant, or similar position, at home or abroad; low salary; free trial up to three months, or monetary guarantee if required; splendid references.—Address, P537, Engineer Office, 33, Norfolk-street, Strand. P537

Civil Engineer, 14 Years' Experience Colonies and E. Europe on surveys and construction of railways, &c., SEEKS ENGAGEMENT, home or abroad; tacheometer expert.—Address, P473, Engineer Office, 33, Norfolk-street, Strand, W.C. P473

Contractor's Agent (M. Inst. C.E.) is OPEN to ENGAGEMENT, home or foreign. Just completed heavy contract (4½ years), and has long and varied experience in railway construction and maintenance and waterworks, including heavy bridging, foundations, and tube tunnel work; accustomed to foreign and colonial labour.—Address, P474, Engineer Office, 33, Norfolk-street, Strand, W.C. P474

English Engineer, A.R.C.S., Open to ACCEPT POSITION as MANAGER at Home or Abroad, preferably in a large CEMENT WORKS; long experience on Continent, especially in one of largest cement works in Germany; thorough knowledge of rotary kilns, and practical possibility of utilising waste gases of same; expert in crushing, grinding, and conveying machinery.—Address, 1760, Engineer Office, 33, Norfolk-street, Strand, W.C. 1760

Gentleman, Civil Engineer, Age 29, SEEKS POST as RESIDENT or ASSISTANT ENGINEER at home or abroad; technical training and 9 years' experience in dock, harbour, and accessory works of the heaviest description at home and abroad, with responsible office and outdoor work; can take up appointment April, 1905.—Address, P266, Engineer Office, 33, Norfolk-street, Strand, W.C. P266

Mechanical, Locomotive, and ELECTRICAL ENGINEER (32).—Gentleman, A.M.I.M.E., 16 years' experience, DESIRES RESPONSIBLE POSITION in Engineering Works, Railway Loco., or Signal Works; experience as head draughtsman, 2½ years on narrow-gauge locomotives; good knowledge of latest improvements in machinery and expeditious output; Locomotive Inspector or Assistant Manager or the like preferred; excellent references.—Address, P449, Engineer Office, 33, Norfolk-street, Strand, W.C. P449

Practical Engineer (30) is Open to CONSIDER POSITION in first-class firm as MANAGER, LONDON REPRESENTATIVE, or OTHER RESPONSIBLE POST; technically educated, of good address, and excellent connection among engineers and architects. For particulars, address, P553, Engineer Office, 33, Norfolk-street, Strand, W.C. P553

Structural Steelwork.—Gentle- MAN (31), sound practical and theoretical experience in steel bridge, roof and girder work, SEEKS permanent POSITION of TRUST as ASSISTANT MANAGER, CHARGE of LONDON OFFICES or CHIEF of DRAWING-OFFICE.—Address, P542, Engineer Office, 33, Norfolk-street, Strand, W.C. P542

Young Engineer (23) Desires EXPERIENCE with a good Firm of TOOL MAKERS or GENERAL ENGINEERS, either shop or office; 4½ years' apprenticeship, including 1 year D.O., with good tool firm.—Address, P541, Engineer Office, 33, Norfolk-street, Strand, W.C. P541

Assistant Draughtsman (23) SHORTLY DISENGAGED; college education, 3 years' shop, 3 years' d.o., general experience.—Address, P549, Engineer Office, 33, Norfolk-street, Strand, W.C. P549

Railway Draughtsman (28) (Permanent Way) is OPEN for APPOINTMENT at home or abroad; three years' experience in the Argentine Republic; speaks Spanish.—S. P., 12, Eaton-square, Monkstown, Dublin. P525

Foreman Bridge Erector, Dis- ENGAGED by end of month, SEEKS RE-ENGAGEMENT, accustomed to cylinders, screw-piles, piers, dock gates, and constructional work.—Address, P507, Engineer Office, 33, Norfolk-street, Strand, W.C. P507

Practical Engineer Seeks Situa- TION as FOREMAN; well up in modern methods, quick and efficient.—Address, P530, Engineer Office, 33, Norfolk-street, Strand, W.C. P530

Up-to-date Machine Foreman WANTS PERMANENCY.—Address, P540, Engineer Office, 33, Norfolk-street, Strand, W.C. P540

Engineer-Mechanic, Up to Date, SEEKS SITUATION; care of engines, boilers, and machinery. Distance no object; good refs.—J. S., 48, Westbourne-road, Barnsbury, London, N. P556

Fitter, a First-class Workman, DESIRES SITUATION abroad; mining experience in South and West Africa, and well up in loco. work.—H. C., Postoffice, Bradford. P539

Good All-round Mechanic Seeks SITUATION, used to Lathe, Planing and Shaping, and Vice; total abstainer, varied experience; could take foreman's place.—10, Palmerston-road, Forest Gate, E. P529

Engineering Pupil.—A Firm of Engineers in the West of England have a VACANCY for a premium PUPIL.—Address, 1114, Engineer Office, 33, Norfolk-street, Strand, W.C. V1114

Engineering Pupil.—Firm (Government Contractors), employing 500 hands, have VACANCY; varied classes of work done, affording excellent opportunities; premium moderate.—Address, 4, Engineer Office, 33, Norfolk-street, Strand, W.C. V4

Engineers, Manufacturing and Consulting, have a VACANCY for a well-educated YOUTH as PUPIL to go through office and shops; premium required; good opening; Birmingham district.—Address, 1764, Engineer Office, 33, Norfolk-street, Strand, W.C. 1764

Surveying, Levelling, &c.— Exceptional opportunity for ACQUIRING thorough practical INSTRUCTION on Works.—Address, P435, Engineer Office, 33, Norfolk-street, Strand, W.C. P435

An Opening is Offered to a Good Working Fitter and Bench Man TO JOIN in a SMALL but GOOD BUSINESS, with £500 capital; road haulage, traction engines, and threshing machinery. No one need apply but those used to the above class of work.—Address, 1776, Engineer Office, 33, Norfolk-street, Strand, W.C. 1776

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Civil Engineer (42), M.I.C.E., with capital at disposal, is ANXIOUS to JOIN FIRM of CIVIL ENGINEERS in good practice; 23 years' experience on railway work in London, provinces, and abroad, especially tunnel and tube work.—Address, P554, Engineer Office, 33, Norfolk-street, Strand, W.C. P554

Partnership (Active) Required by fully-qualified man with capital of £3000 to £5000 in a sound established ENGINEERING CONCERN; London or country.—Particulars to ARNOLD and CO., 60, Queen Victoria-street, London, E.C. 1773

Accountant's Clerk, Experienced in engineers' accounts, PREPARES BALANCE SHEETS and Assists in Accounts during evenings; income tax accounts prepared; excellent references.—Apply, H. BRADELEY, 64, Grantham-road, Stockwell, S.W. P569a

C. Schreiber, Draughtsman and Engineer. DRAWINGS and TRACINGS of all kinds; INVENTIONS PERFECTED; difficult PROBLEMS WORKED OUT.—54, Stoney Stanton-road, Coventry. P535

Development of British Engi- NEERING INDUSTRIES.—A Consulting Engineer, considering professional visit to India, and possibly Australia, is Disposed to Undertake Reports, Inspection, &c.—"D," 44, Chancery-lane. 1768

Engineers' Working Drawings AND TRACINGS.—Inventors' IDEAS WORKED OUT and MODELS MADE; 23 years' experience; charges moderate.—J. H. TODD, 67-69, Chancery-lane W.C. P146

Titley and Wall, Consulting and INSPECTING ENGINEERS and VALUERS, TUBE and ROLLING MILL EXPERTS. CURZON CHAMBERS, PARADISE-STREET, BIRMINGHAM. T101a

STRUCTURAL STEELWORK.
CORRESPONDENCE TUITION.
Thorough Tuition in BRIDGEWORK of all types, ROOFS of all descriptions, BUILDINGS on the American and Continental plan, &c. Also in PRACTICAL MATHEMATICS, APPLIED MECHANICS, STEAM, &c. Courses framed for Examinations. Send for Descriptive Booklet E, naming subject required. 1190
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Wanted, Every Engineer to Send for FREE COPY of "THE ENGINEERING DIARY" (published monthly, pocket size).
Contains data and tables of interest and information to engineers of all classes.
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Wanted, Capstan Lathe, with and without back gear; must be equal new. Also 5-Tons ELECTRIC CRANE, about 30ft. span.—Address, 1722, Engineer Office, 33, Norfolk-street, Strand, W.C. 1722

Wanted, Light Draught Self- PROPELLED SUCTION HOPPER DREDGER, about 10in. pump and 100 to 200 tons hopper capacity; or HOPPER BARGE, as above, suitable for equipment with suction gear.—Apply, CHAS. D. OLIVER, M. Inst. C.E., 3, Kildare-place, Dublin. 1761

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WHEEL-TURNING LATHE, to take 8ft. diameter.
Three RADIAL DRILLING MACHINES, 5ft. and 6ft. arms.
SHAPING MACHINE, 10ft. bed, 2 tables, 20in. stroke, quick return.
Powerful Double-ended PUNCHING and SHEARING MACHINE, engine-driven.
SCREW-CUTTING and SURFACING LATHES, from 6in. to 14in. centres.
12in. Stroke SLOTTING MACHINE.
Low prices.
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Boilers, Two Cornish, Insured 100 lb. steam, new 1902, 23ft. long, 6ft. dia., 3ft. flue and cross tubes.—THOMPSON, Maria-street, Millwall. P560

Crane, Three-Ton Steam Travel- LING and all motions, 35ft. steel jib; good condition; makers, Stothert and Pitt.—THOMPSON, Maria-street, Millwall. P551

Engine and Boiler, Undertype, by Marshall, 30 N.H.P., cyls. 11in. and 17in., by 2ft. stroke; boiler 140 lb., with jet condenser.—THOMPSON, Maria-street, Millwall. P552

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Horizontal CORLISS CONDENSING ENGINE, by Hick, Hargreaves; 24in. cyl., 48in. stroke.
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Pair 21in. Horizontal Side-by-side TANDEM CONDENSING ENGINES, by Nasmyth and Wilson; 48in. stroke.
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THE AVONSIDE ENGINE COMPANY,
BRISTOL. Y949

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One new, 12in. centres, SLIDING, SURFACING and SCREW-CUTTING LATHE, on 16ft. box-end gap bed, with three-handle feed motion.
One 12in. by 12ft. ditto, ditto.
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One 8in. by 8ft. ditto, ditto.
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One 6in. by 6ft. SLIDING, SURFACING, and SCREW-CUTTING LATHE, with special fast headstock with four-speed cone, parallel bearings, 2in. hole through spindle, sliding loose head, and four studs and two bars on top square.
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One 10in. to 12in. stroke SHAPING MACHINE, 3ft. bed, with circular motion and one pair vice.
One 8in. stroke SHAPER, 2ft. 9in. bed, with circular motion.
One 16in. BENCH DRILL, with hand feed.
One 36in. Double Geared Vertical Pillar DRILL.
One PLANING MACHINE, to plane 6ft. long, 36in. wide 30in. high, with one tool-box on cross-slide.
One PLANING MACHINE, to plane 6ft. by 2ft. by 2ft. with two tool-boxes on cross-slide.
One PLANING MACHINE, to plane 10ft. long, 3ft. high, 3½ft. wide, from 3ft. square models, with two tool on cross-slide and one side tool on near standard.
All the above machines are new, and in stock for immediate delivery.
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Two sound LANCASHIRE STEAM BOILERS; dimensions, 26ft. × 7ft. 6in.; double flues; working pressure, 100 lb.; and 26ft. × 6ft. 6in.; double flues; working pressure, 70 lb.
Both boilers certified by Vulcan Insurance Company.
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For Sale, Boiler Shell Drilling MACHINE, with four radiating arms, for marine work; in good condition, and our own make.—Apply, CAMPBELLS and HUNTER, Ltd., Dolphin Foundry, Leeds. 1714

For Sale, Boilers, Lancashire, insured for 110 lb. working pressure, new and only worked short time; sizes, 27ft. by 7ft. 6in. and 27ft. by 7ft.; two furnaces each, all mountings, fittings, &c.; makers, Foster and Co.; now at Norwich Railway Station; specification and boiler insurance report can be forwarded.
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For Sale, Cheap, 6 H.P. Inside- GEARED Fowler TRACTION ENGINE; also 7 and 8 H.P. Burrell TRACTION ENGINES. Ready immediate delivery.—GRAVEN, Ely, Cambs. T32

For Sale, Double-ended Punch- ING and SHEARING MACHINE, to punch 1in. through 1in. and shear 1in., with 24in. gape, angle iron shears in middle to cut 6in. by 6in., stop motion, belt driven, overhead crane.—WILLIAMS and SONS, South Bermondsey Station, London. 1759

For Sale, High-class Coupled Condensing STEAM ENGINE, cylinders 20in. diameter, 42 stroke, 60 revolutions, 60 lb. boiler pressure, fitted with short ports, expansion gear, feed pump, two air-pumps and condensers; each side can be worked independently; can be seen in position.—Address, GEO. BAZELEY and SONS, Pensance. P464

For Sale or Hire :—
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PLOUGHING ENGINES and Implements.
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For Sale, Splendid Vertical MILLING and DRILLING MACHINE, by Hulse, 20in. circular table, 21in. traverse; cheap for prompt delivery.—WILLIAMS and SONS, South Bermondsey Station, London. 1758

For Sale :—Steam Engine, Com- POUND Vertical Inverted type, cylinders 12in. and 20in. × 20in. stroke.
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NEW GAS ENGINES, all sizes, 1½ to 700 H.P.
PUMPING ENGINES, of Compound Duplex type, Second-hand, 20,000 gallons per hour capacity.
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GLOUCESTER. Y344

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Both boilers made of steel plates, with all holes drilled and best possible construction.
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One 14in. " 4ft. 8½in. gauge, nearly ready.
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Triple-Expansion Engines, suitable for a Twin-screw Vessel, for SALE; cylinders 12in. and 20in. and 32in. × 22in. stroke; for 180 lb. working pressure; equal to new; built under R.O.T. and Lloyd's inspection by Beardmore and Co., of Glasgow, for the Pacific Steam Navigation Company's s.s. Talca; only worked a few weeks.—Apply, LYTHAM SHIPBUILDING and ENGINEERING COMPANY, Lytham. V12

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25 H.P. Portable Engine for HIRE; also all small sizes, 3 to 20 H.P.; MORTAR MILLS, 6ft. to 8ft.—WILLSHIRE and CO., 16, Parade, Forest Hill, S.E. P532

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The following GOODS are for IMMEDIATE DISPOSAL, and at the prices affixed they are an exceptional bargain:—
Plate Edge PLANING MACHINE, to plane plates, 12ft. 6in. wide; reversing gear, down feed, turn-over tool box; by Shepherd, Hill and Co. £110.
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Two very powerful HEADSTOCKS and FACE-PLATES, 55in. and 60in. centres, for heaviest work.
Marshall's Undertype ENGINE and BOILER, two 10in. cylinders, nearly new, 150 lb. pressure, cheap.
Powerful PUNCH and SHEAR, with angle shears, 1¼in. plates and holes, 21in. gaps, by Berry.
For appointments to inspect and full particulars apply—
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NOTTINGHAM. Q176

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MAKERS OF HIGH-CLASS MACHINE TOOLS.
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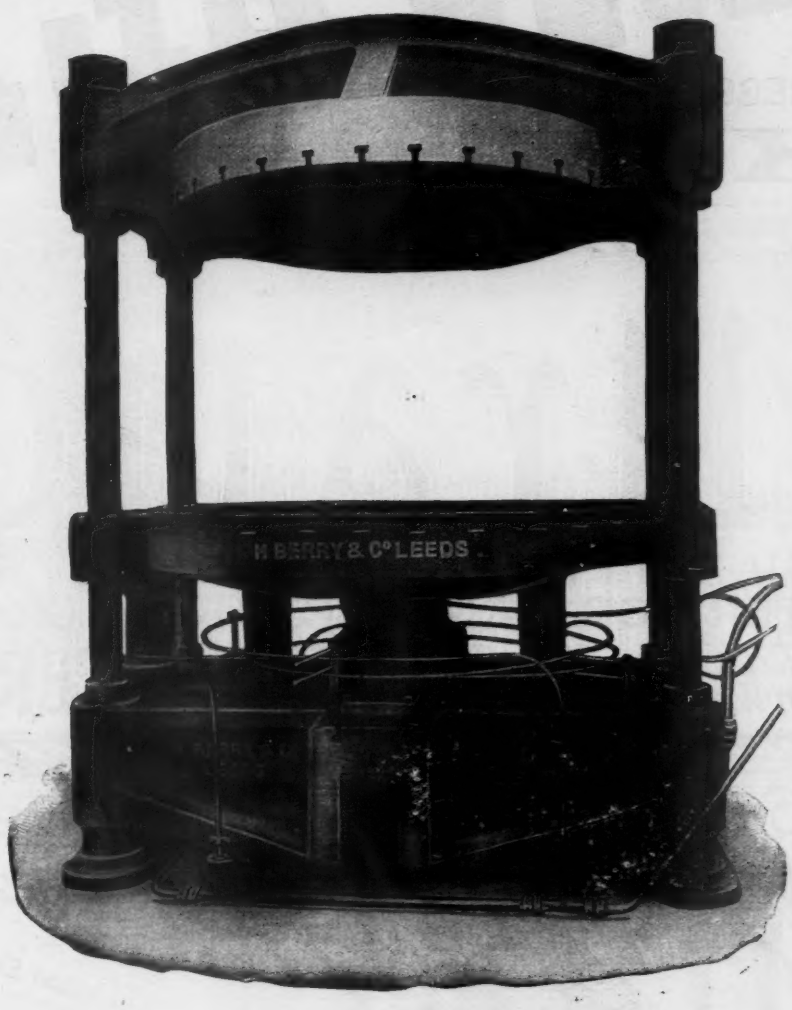

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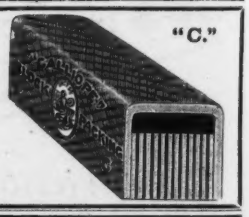

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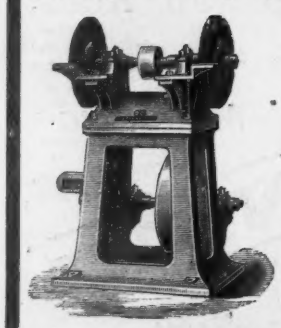

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BREACH, GALSWORTHY and CO. will SELL by AUCTION at the Mart, Tokenhouse-yard, E.C., on THURSDAY, February 9th, 1905, at Two o'clock precisely, the compact FREEHOLD FACTORY PREMISES, occupying a valuable position close to Addiestone Railway Station. The principal buildings are in three detached blocks, substantially built in brick, with tiled and slated roofs, having a floor area of about 23,000 square feet. There are also numerous timber-built sheds and stores. The premises have been thoroughly well maintained, and are readily adaptable to the requirements of any printing or manufacturing firm, motor or engineering works, or any other trading concern contemplating the removal of their business to the suburbs. There are also eight cottages which would be useful in connection with the factory. The river Bourne forms the southern boundary of the property, affording an unlimited supply of water. The 150 H.P. horizontal engine and powerful Lancashire and vertical boilers, with the main shafting, will be included in the purchase.—Particulars may be had of Messrs. Claude Jessett and Son, Solicitors, 17, Clement's-lane, E.C.; at the Mart; and of Messrs. FAREBROTHER, ELLIS and CO., 29, Fleet-street, E.C. 1735

Factories (Waterside and Inland),

WHARVES, WAREHOUSES, LAND, &c.—Largest REGISTER, issued free by

LEOPOLD FARMER and SONS,

Auctioneers, Surveyors, and Specialists in Waterside Property, 46, Gresham-street, Bank, E.C., and Kilburn. BK347

By order of the Mortgagee of Sea Gorge, Limited.—WITH POSSESSION.—HATTON-GARDEN WORKS, 36, ST. ANN'S-ROAD, SOUTH TOTTENHAM, five minutes of Stamford-hill station, 25 minutes from City.—FREEHOLD MODERN MANUFACTURING PROPERTY, comprising well-lighted shop (76ft. by 61ft.), ware rooms, engine-house with 35 H.P. gas engine, offices, yard, also dwelling-house let at £26 per annum. The property covers an area of about 14,000ft., estimated rental value £360 per annum.

Leopold Farmer and Sons will

SELL by AUCTION, at the MART, E.C. on WEDNESDAY, January 18th, 1905, at Two, the above PROPERTY. Plans, particulars, and conditions of Sale of Messrs. Head, Mole and Roeling, Solicitors, Reigate, Surrey, and the AUCTIONEERS, 46, Gresham-street, E.C., and Kilburn, N.W. 1718

To Engineers, Manufacturers, and Others.—With Possession.—ENGINEERING PREMISES, KING'S CROSS, known as 42 and 43, REGENT-SQUARE; block of BUILDINGS in SEAFORD-STREET; and 30 to 40, HARRISON-STREET, GRAY'S-INN-ROAD, situate in a central position, within 10 minutes' walk of Euston, St. Pancras, and King's-cross Stations, comprising large engineering shops, with artesian well, warehouses, stores, joinery shops, smithies, offices, &c., the whole covering an area of about 20,000ft.; estimated rental value £700 per annum, and held on lease for a term of 50 years at a ground rent.

Leopold Farmer and Sons will

SELL by AUCTION, at the Mart, E.C., on WEDNESDAY, January 18th, 1905, at Two, the above desirable PROPERTY, in one Lot.

Plans, particulars, and conditions of sale of Messrs. Hewlett, Birch-Reynardson and Buckmills, Solicitors, 2, Raymond's-buildings, W.C., and the AUCTIONEERS, 46, Gresham-street, E.C., and Kilburn, N.W. 1719

VALUATIONS.

Wood and Newland,

42, SPRING GARDENS, MANCHESTER, VALUERS and AUCTIONEERS to Engineering and Allied Trades. BK116

Partnerships and Transfer of Businesses negotiated.

Parliamentary Deposit of Plans.

NOVEMBER, 1904.

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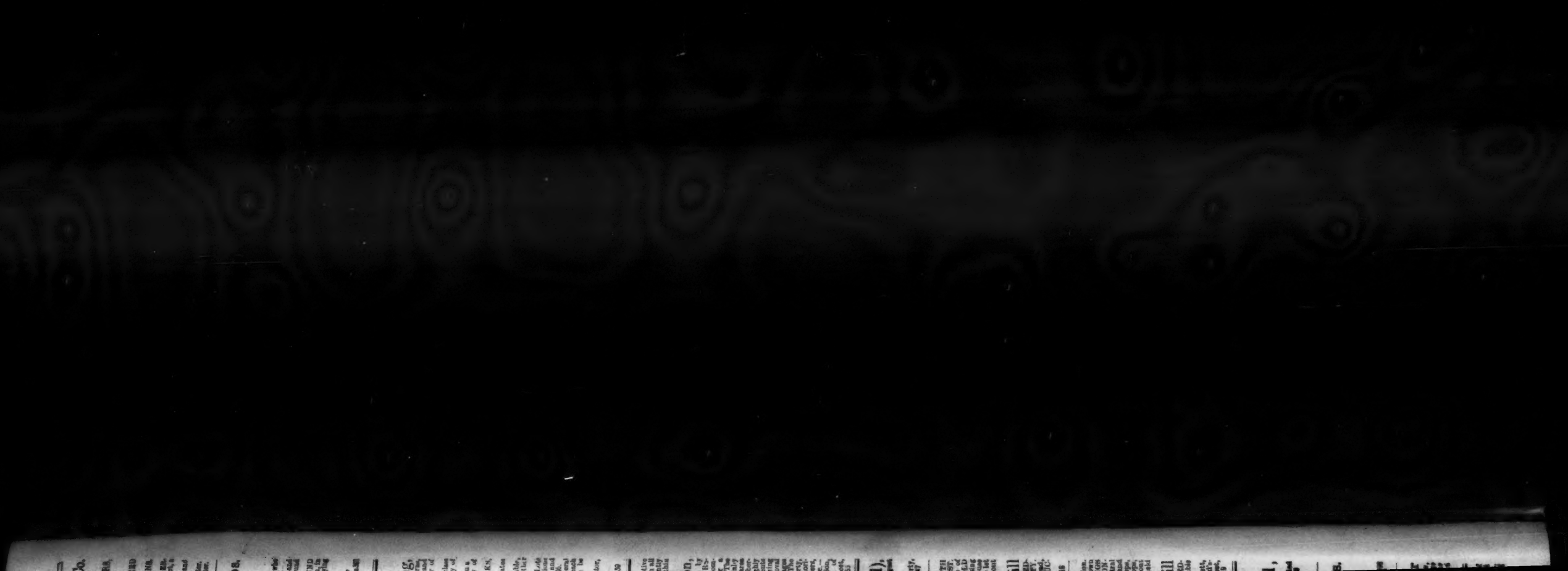
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